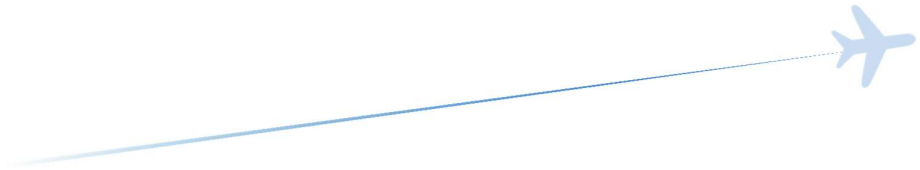

SESAR SOLUTION PJ.11-A4 (SA+): Initial COST BENEFIT ANALYSIS (CBA)

Deliverable ID:	**PJ.11-A4 T6.110**
Dissemination Level:	**PU**
Project Acronym:	**CAPITO**
Grant:	**732996**
Call:	**H2020-SESAR-2015-2**
Topic:	**SESAR.IR-VLD.Wave1-15-2015**
Consortium coordinator:	**EUROCONTROL**
Edition date:	**3rd April 2018**
Edition:	**00.00.02**
Template Edition:	**02.00.01**

Founding Members

EUROPEAN UNION EUROCONTROL

SESAR JOINT UNDERTAKING

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Document History

Edition	Date	Status	Author	Justification
00.00.01	02/03/2018	First draft	Eva Jošth Adamová, Renka Balážová	First draft provided to partners for review.
00.00.02	03/04/2018	Final draft of initial CBA	Eva Jošth Adamová	Reviewer's comments addressed. Sent for final approvals.

00.01.00	16/04/2018	Final version	Eva Jošth Adamová	Approved by partners

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CAPITO

PJ.11 CAPITO

This COST BENEFIT ANALYSIS (CBA) for V1 is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 732996 under European Union's Horizon 2020 research and innovation programme.

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1 Executive Summary

In V1, the CBA focuses more on scoping the solution, identifying its interdependencies on other solutions and implementation options, the stakeholders impacted, describing in qualitative terms the BIMs in the OSED, including the most impacted KPAs and KPIs. Cost drivers are also identified. This work should start jointly with validation activities so that the definition of scenarios and metrics used to capture benefits in validation takes account of the CBA needs. In V1, the output is in principle a qualitative description of the benefits and costs of the solution to the different impacted stakeholders with the aim to ensure understanding what the solution will bring – order of magnitude.

The SESAR solution under the scope of this document is SA+, further referred as TSAA+. SA+ capability refers to enhancement of already standardized ADS-B IN Traffic Situational Awareness with Alerts (TSAA) application enhanced to use information about intruder's RA (Resolution Advisory), if TCAS-equipped and indicate it to Pilot. Such enhancement is referred as TSAA+ and its operational concept is built upon TSAA.

2 Introduction

2.1 Purpose of the document

This document is a CBA report for Solution PJ11-A4, Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp, addressing TSAA+ capability.

Since CBA document is required for V2 maturity gate. In V1 phase, only basic sections, relevant for V1 will be filled in. In V1, the CBA focuses on scoping the solution, identifying its interdependencies on other solutions and implementation options, the stakeholders impacted, describing in qualitative terms the Benefit Impact Mechanism, including the most impacted KPAs and KPIs. Cost drivers are also identified.

Some of the elements listed in this document are indirect benefits and costs to some stakeholders and will not be part of the CBA model (i.e. identification of costs and monetising of benefits where possible).

2.2 Scope

This document provides the CBA for TSAA+ capability within PJ.11-A4. In Wave 1, TSAA+ capability is expected to reach V2 maturity, therefore this document should be completed in order to comply with V2 requirements by 31.10.2019.

In V1, the output is in principle a qualitative description of the benefits and costs of the solution to the different impacted stakeholders with the aim to ensure understanding what the solution will bring – order of magnitude;

2.3 Intended readership

The intended audience is:

- PJ.11 members
- SJU
- Members of PJ.19 and PJ.20

2.4 Structure of the document

Section 1 -> Scope, intended audience, structure, background, glossary of terms and acronyms

Section 2 -> Objective and scope of this CBA

Section 3 -> Qualitative description of the benefits

Section 4 -> Cost assessment per stakeholder group

Section 5 -> CBA Model and data sources

Section 6 -> results of CBA

Section 7 -> recommendation and next steps

Section 8 -> reference and applicable documents

2.5 Background

No previous activities in TSAA nor TSAA+ domain e.g. previous CBAs or economic appraisals covering the SESAR Solution or parts (precursors) of it have been done yet. Also, no activities considering different ADS-B equipage scenarios (i.e. the currently mandated scenario as of 2020 addressing ADS-B OUT only for large IFR aircraft / mandated + voluntarily equipped / possible future mandate with extension to larger fleet) have been analyzed so far.

This section is omitted, because there is no previous work that can be identified as background.

2.6 Glossary of terms

Term	Definition	Source of the definition
AIRCRAFT	An aircraft is any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.	ICAO Annex 1, Annex 6 Part I
AEROPLANE	A power driven heavier than air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.	ICAO Annex I, Annex 6
AIRPROX	A situation in which, in the opinion of a pilot or a controller, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved was or may have been compromised	ICAO
AIR-REPORT	A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.	ICAO Annex

Automatic dependent surveillance broadcast (ADS-B)	A means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link.	ICAO DOC 10019
Benefit	Benefit is a positive impact of monetary value to stakeholders.	SESAR, ATM CBA for Beginners
Benefit mechanisms	Benefit mechanisms are a cause effect description of the improvement proposed by the project. They show how benefits are delivered.	SESAR, ATM CBA for Beginners
Cash Flow	Cash flow is the difference between the cash inflows and outflows related to the project during the time horizon in which they occur.	SESAR, ATM CBA for Beginners
Cost	Cost is monetary value used up to produce or acquire the benefit.	SESAR, ATM CBA for Beginners
Cost mechanisms	Cost mechanisms are a description of the potential costs of the project broken down into relevant cost categories (e.g. investment, operating).	SESAR, ATM CBA for Beginners
Discount Rate	Discount Rate is a way to capture the time value of money. This is a percentage that represents the increase in the amount of money needed or estimated to keep the same value as one year ago.	SESAR, ATM CBA for Beginners
General Aviation Aeroplanes (GAA)	General Aviation (GA) is defined by ICAO as "all civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire". This encompasses a wide range of activity: • Pilot training • Business aviation • Recreation including balloon, glider and model aircraft flying • Agriculture including crop spraying	PJ11-A4

	• Mail and newspaper deliveries • Transport of dangerously ill people and of urgently needed human organs, medical equipment and medicines • Monitoring ground traffic movements from the air • Civil search/rescue • Law enforcement including operations against smuggling • Aerial survey including photography for map making and pipeline and power cable patrols • Pollution control and fire fighting • Flying displays and aircraft platforms: • Fixed wing • Rotary wing • Unconventional (e.g. balloons, airships, gliders, autogyro) In the context of PJ11-A4 "General Aviation aeroplanes" will indicate Fixed Wing platforms used for GA activities. This PJ11-A4 GA definition will include the EASA Safety Categories: "Aerial Work/Part SPO Aeroplanes" and "Non-Commercial Operations Aeroplanes".	
Inflation	Inflation is a rise in the general level of prices of goods and services in an economy over a period of time.	SESAR, ATM CBA for Beginners
Net Present Value	Net Present Value (NPV) is the sum of all discounted cash inflows and outflows during the time horizon period.	SESAR, ATM CBA for Beginners
NPV Risk Profile	NPV Risk Profile is the range of values the NPV of the project might take along	SESAR, ATM CBA for Beginners

	with the associated cumulative probabilities.	
Rotorcrafts (R)	In the context of PJ11-A4 with Rotorcrafts (or Helicopters) will indicate a rotary wing platform of any size (from Ultra-light to Medium, Heavy) used for GA, Commercial, Aerial Work, Customs, Police activities, including military helicopters as part of their operations in non-segregated airspaces. This PJ11-A4 GA definition will include the EASA Safety Categories: "Commercial Air Transport Helicopters", "Aerial Work/Part SPO Helicopters" and "Non-Commercial Operations Helicopters".	PJ11-A4
Sensitivity Analysis	Sensitivity refers to the impact one given input to the model has on the overall NPV.	SESAR, ATM CBA for Beginners
Stakeholder	Stakeholders are organizations and entities who will have to pay for or will be impacted by the project directly or indirectly.	SESAR, ATM CBA for Beginners
Time Horizon	Time horizon refers to a definite time period during which all cost and benefits related to a given project occur.	SESAR, ATM CBA for Beginners
Time Value of Money	Time Value of Money means that the same (nominal) amount of money received at different points in time has different value	SESAR, ATM CBA for Beginners
Near Mid Air Collision	Near Mid Air Collision (NMAC) occurs when two aircraft come within 100 feet vertically and 500 feet horizontally	TCAS MOPS (DO-185)

2.7 List of Acronyms

Acronym	Definition
A/C	Aircraft
ACAS	Airborne Collision Avoidance System

ACAS Xa	ACAS X – Active
ACAS Xp	ACAS X – Passive
ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-R	ADS-B Rebroadcast
ANSP	Air Navigation Service Providers
ATC	Air Traffic Control
ATM	Air Traffic Management
FAA	Federal Aviation Administration
GA	General Aviation
HC	High complexity (airport)
LC	Low complexity (airport)
MAC	Mid-Air Collision
NMAC	Near Mid-Air Collision
RA	Resolution Advisory
SA+	Enhanced Situation Awareness (TSAA+)
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
TAS	Traffic Advisory System
TCAS	Traffic Alert and Collision Avoidance System
TMA	Terminal Manoeuvring Area
TSAA	Traffic Situation Awareness with Alerts
TSAA+	Enhanced TSAA (refer to SA+)

"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."

3 Objectives and scope of the CBA

3.1 Problem addressed by the solution

The risk of collision between ACAS equipped and unequipped a/c (GA/R/military) needs to be addressed. During such mixed equipage encounters, a/c are likely to manoeuvre against each other. These encounters are not addressed so far.

Currently existing collision avoidance systems are not tailored for a/c of GA/R/military performance.

3.2 SESAR Solution description

The SESAR solution under the scope of this document is SA+, further referred as TSAA+. SA+ capability refers to enhancement of already standardized ADS-B IN Traffic Situational Awareness with Alerts (TSAA) application enhanced to use information about intruder's RA (Resolution Advisory), if TCAS-equipped and indicate it to Pilot. Such enhancement is referred as TSAA+ and its operational concept is built upon TSAA.

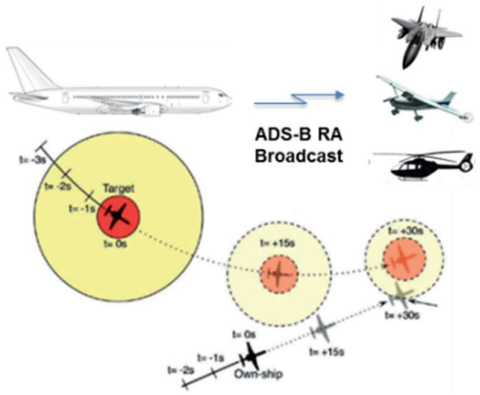


Figure 1: TSAA+ pictorial view

TSAA+ aims to address mixed equipped encounters, e.g. encounters involving TCAS-equipped and non-TCAS-equipped aircraft which are one of the remaining sources of mid-air collision (MAC) risks. TSAA+ is intended to provide timely alerts of qualified airborne traffic in the vicinity of ownship in order to increase flight traffic situation awareness, and if TCAS II-equipped traffic is issuing an RA (against ownship or any other traffic), then the information about RA will be passed to the flight crew. TSAA+ application is intended to reduce the risk of NMAC or MAC by aiding in visual acquisition, and to avoid TSAA+ pilot to manoeuvre against RA of TCAS II-equipped aircraft (e.g. idea is NOT to manoeuvre against TCAS II manoeuvring aircraft).

The TSAA+ is intended for any civil or military, powered aircraft or rotorcraft which is not under TCAS II mandate. It is intended to operate in any airspace (controlled or uncontrolled) with various traffic density; in IMC or VMC; during IFR or VRF flights; during departure, en-route or approach operations when there is a potential of encounters with commercial, TCAS II-equipped aviation. TSAA+ will only be effective against those aircraft with ADS-B Out equipment is installed and operational.

This SESAR solution is from the EATMA point of view addressed under PJ11-A4, Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp, but since ACAS Xp and TSAA+ are two different capabilities, PJ11-A4 will be most likely split in the near future. Once final decision about the solution split is done, the solution description, OI step and enablers will be refined.

SESAR Solution ID	OI Steps ref. (coming from the Integrated Roadmap)	OI Steps definition (coming from the Integrated Roadmap)	OI step coverage	Comments on the OI step title / definition
PJ11-A4	CM-0808-p	Collision Avoidance for General Aviation and Rotorcraft (ACAS Xp)	**Partial**	This document covers only SA+ capability of the solution.

Table 1: SESAR Solution PJ.11-A4 (TSAA+) Scope and related OI steps

OI Steps ref.	Enabler[1] ref.	Enabler definition	Enabler coverage	Applicable stakeholder	Comments on the Enabler / definition
CM-0808-p	A/C 54a	Enhanced ACAS	All ECAC States	AU and ANSPs	Enhanced ACAS with reduced threshold, use of ADS-B horizontal information, extended hybrid surveillance for non-ACAS aircraft with ACAS aircraft improved compatibility with US ACAS Xa.

Table 2: OI steps and related Enablers

Source: Dataset 16 EATMA

3.3 Objectives of the CBA

The objective of this CBA is to gather a qualitative description of the benefits and costs of the solution(s) to the different impacted stakeholders with the aim to ensure understanding what the solution will bring – order of magnitude.

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

Solution PJ11-A4 starts at the V1 phase with the aim to complete V2 phase by end of Wave 1 and conclude V3 level early in Wave 2.

3.4 Stakeholders identification

This section includes the stakeholders and impacts captured in the CBA.

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
Airspace Users - Pilots (GA/R/MIL)	Direct	**Benefit:** Improved situational awareness of GA pilot (by using visual information) Less NMAC and MAC Increased confidence of GA pilot knowing manoeuvre intruder is about to take Decreased risk of GA aircraft manoeuvring against TCAS equipped aircraft **Dis-benefit:** Pilot overload/ disruption (operational risk introduced by reduced look-out-of-window time) leading to increased risk of conflict with non ADS-B traffic **Cost:** Equipage cost Cost of operating/ maintaining it Potential training cost	Thomas Oster (ECTRL) PJ11 Focal Point (MIL) EUROCONTROL, AOPA, Honeywell, internal pilots.	N/A
ANSP	Indirect	**Benefit**: Decreased risk of NMAC/MAC. **Cost**: N/A	DSNA – Christian A. (PJ.11-A1)	N/A
Airspace Users (Airlines)	Indirect	**Benefit**: Potential reduction in NMAC. **Cost**: no costs for airlines	N/A	N/A
National governments / administrations & organizations	Indirect	**Benefit**: Less NMAC - less time spent on analysis of accidents.	EUROCONTROL (?)	N/A

		Cost: Expenses in terms of co-financing for R&D work Less NMAC- less time spent on analysis of accidents - decreased costs		
Airborne industry	Indirect	**Benefit**: No benefits. Profit is not considered as benefit in the sense of CBA. **Cost**: Development costs	Honeywell, Thales, Leonardo	N/A

Table 3: SESAR Solution PJ.11-A4 (TSAA+) CBA Stakeholders and impacts

3.5 CBA Scenarios and Assumptions

This section describes the scenarios that will be compared in the CBA, and are based on the following assumptions that were applied for BIM development:

- As a baseline, it is considered that GA/R/MIL aircraft are not equipped with any ADS-B In situational awareness system (TSAA or similar).
- Solution is addressing European airspace (no ADS-R or TIS-B)
- To assess the benefits, it is assumed that solution is fully implemented in the environment where it is expected to have the most benefits.
- Benefits and costs introduced by ADS-B on G/A are not addressed in this document.
- Profit for airborne industry is not considered as benefit in sense of CBA.

3.5.1 Reference scenario

Intended aircraft (powered aircraft not under TCAS II mandate, both civil and state airplanes and rotorcraft that operate in non-segregated airspaces) operating in both controlled and uncontrolled airspace, under IFR and VFR rules, in both IMC and VMC conditions are at the start of implementation not equipped with any ADS-B In situational awareness system.

Some of the intended aircraft may be equipped with TAS (Traffic Advisory System), however this system is not expected to be further deployed due to its high price and low performance.

Key enabler, ADS-B Out is in the deployment phase (targeting primarily NOT intended aircraft types), but it is assumed that within the CBA time-horizon, 2025-2035, the ADS-B Out capability will be deployed among intended aircraft types too."

3.5.2 Solution scenario

ADS-B Out is fully deployed not only among currently mandated aircraft types, but among intended aircraft types too. (recommendation).

All intended aircraft are equipped with TSAA+ system.

Initial operations (initial date when enough a/c can benefit of the application): 2025

Full operations (all relevant a/c equipped): depends on ADS-B Out deployment within GA community. Assumption: 2030.

4 Benefits

In this section, the potential capabilities of TSAA+ to enable or deliver benefits are presented.

Positive impact

Benefits are connected with 2 focus areas – Safety Improvement and Human performance.

1. **Safety benefits**

   - **Improved situational awareness**

Improved situational awareness means that GA/R/MIL pilots would, thanks to TSAA (+) system which takes advantage of surveillance data from passive sources (ADS-B), be able to have improved awareness of the surrounding traffic in vicinity. Moreover, with TSAA+, if TCAS II – equipped traffic is issuing an RA (against ownship or any other traffic), then the information about RA will be passed to the flight crew. This increases the pilot's situational awareness of threats and so assists the pilot in when and where to look out the cockpit to acquire the approaching aircraft.

Situational awareness will be improved, if the number of see and avoid failures will decrease. This solution should reduce the failures of see and avoid between ACAS-equipped and GA traffic fitted with the TSAA+ system.

   - **Less NMAC and MAC**

Improved situational awareness leads to reduced risk of NMAC and MAC. Safety is considered to be increased if number of NMAC and MAC decrease in both TMA and En-Route environments where TSAA+ will operate. Increased situational awareness of ACAS-RA occurring nearby will lead to better reactions to unexpected aircraft manoeuvres. GA pilot will have more information to avoid creating an induced conflict situation (NMAC and MAC).

   - **Decreased GA vs. TCAS manoeuvring risk**

Goal is the reduction in unnecessary or counter-productive manoeuvres of GA traffic (by altitude or by turns) to ACAS-RA manoeuvring aircraft in their vicinity. Reducing the creation of new conflict situations with either the ACAS reacting or other nearby aircraft by increasing situational awareness of ACAS-RA triggered manoeuvres in their vicinity. Altitude and trajectory deviations triggered by misunderstanding of ACAS-RA obeying aircraft will lead to less Induced GA involved conflicts.

Increased situational awareness of ACAS-RA occurring nearby will lead to better reactions to unexpected aircraft manoeuvres. GA pilot will have more information to avoid creating an induced conflict situation.

2. **Human performance benefit**

   - **Increased GA pilot confidence**

The TSAA+ system displays the TCAS-RA and gives an audible warning with positional information to the GA pilot. This corresponds to an increase in the performance of the detection and in the decision making as regards making a successful see and avoid manoeuvre.

Due to provided RA information (Climbing or Descending), GA pilot can also react in a collaborative way to the aircraft.

Negative Impact

Affecting both focus areas (Safety and Human performance)

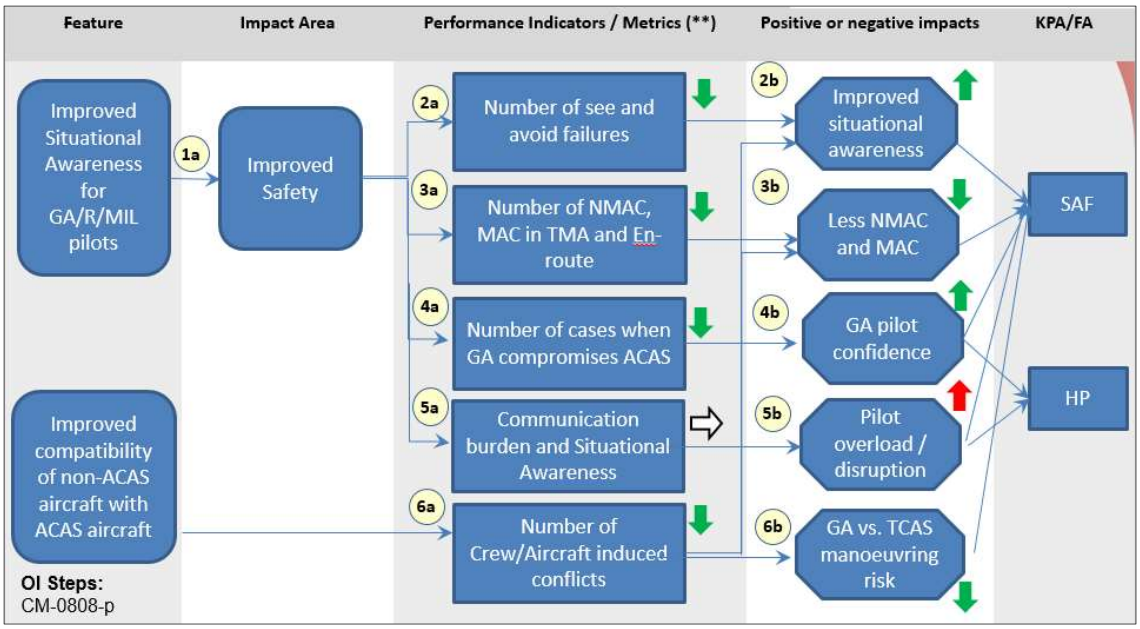
- **Pilot's overload**

Communication burden and situation awareness is indicator that needs to be assessed (impact is not yet clear) in relation to safety. It is linked to pilot potential disruption by TSAA+ application, aural alerts may even be too disturbing or useless due to increased noise level in GA aircraft.

- **Pilot's reduced attention to non-ADS-B traffic**

Paying too much attention to TSAA+ application on board may cause GA pilot missing some non-ADS-B traffic. This impact is in the BIM addressed under "Pilot overload/disruption".

4.1 Benefit Impact Mechanisms



Feature description

#1

Improved situational awareness means that GA/R/MIL pilots would thanks to TSAA (+) system, which takes advantage of surveillance data from passive sources (ADS-B), be able to have improved awareness of the surrounding traffic in vicinity. Moreover, with TSAA+, if TCAS II – equipped traffic is issuing an RA (against ownship or any other traffic), then the information about RA will be passed to the flight crew. Improved situational awareness leads to reduced risk of NMAC or MAC.

#2

TSAA+ address mixed equipage encounters, e.g. encounters involving TCAS-equipped and non-TCAS-equipped aircraft which are one of the remaining sources of mid-air collision (MAC) risk. There is no coordination between TSAA+ application and alerting systems on other aircraft, but TSAA+, providing with the ability to receive and process RA broadcast from TCAS-equipped aircraft, can be considered as a first step toward responsive coordination, which strategy requires that intended aircraft knows it is the intruder aircraft for the TCAS-equipped aircraft. TSAA+, as a situational awareness application, will not provide flight crew with maneuver guidance or commands.

Note to Safety KPI – as such SAF KPI is not measured. SESAR2020 solutions shall actively collect safety-related data on the precursors of the KPI in terms of the different Safety PIs that can be used to assess the trend of safety performance.

Explanatory Notes

(1a) Improved situational awareness leads to reduced risk of NMAC and MAC thus to improved Safety.

(2a+2b) Safety will be improved is number of see and avoid failures will decrease, e.g. situational awareness will be improved.

(3a+3b) Safety is considered to be increased if number of NMAC and MAC decrease in both TMA and En-Route environments where TSAA+ will operate.

(4a+4) Safety is increased if there is a decrease in number of cases when GA traffic compromises an ACAS-RA on nearby equipped aircraft, intended to resolve a potential collision with it, by not being aware of its existence.

(5a+5b) Communication burden and situation awareness is indicator that needs to be assessed (impact is not yet clear) in relation to safety. It is linked to pilot potential disruption by TSAA+ application, aural alerts may even be too disturbing or useless due to increased noise level in GA aircraft. Paying too much attention to TSAA+ application on board may cause GA pilot missing some non-ADS-B traffic.

(6a+6b,3b, 2b) Improved compatibility of non-ACAS aircraft with ACAS aircraft can be measured by number of crew/aircraft induced conflicts. Goal is the reduction in unnecessary or counter-productive manoeuvers of GA traffic (by altitude or by turns) to ACAS-RA maneuvering aircraft . Reducing the creation of new conflict situations with either the ACAS reacting or other nearby aircraft by increasing situational awareness of ACAS-RA triggered manoeuvres in their vicinity leading to less NMAC and MAC.

Performance Framework KPA[2]	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+x	Year N+y
Safety	Safety improvement by "Improved Situational Awareness for GA/R/MIL pilots"	**SAF1** Accidents/incidents with ATM contribution	%	Number of see and avoid failures	€/year			
				Number of NMAC, MAC in TMA and En-route	€/year			
				Number of cases when GA compromises ACAS	€/year			
				Communication burden and Situational Awareness	€/year			
	Safety Improvement by "Improved compatibility of non-ACAS aircraft with ACAS aircraft"	**SAF1** Accidents/incidents with ATM contribution	%	Number of Crew / Aircraft induced conflicts	€/year			

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

Performance Framework KPA[2]	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+x	Year N+y
Human performance	Improved Situational Awareness for GA/R/MIL pilots	**HP1** Role consistency	Qualitative Quantitative	Number of cases when GA compromises ACAS	€/year			
				Communication burden and Situational Awareness	€/year			

Table 4: Results of the benefits monetisation per KPA

5 Cost assessment

The following chapter presents the results of the initial cost assessment associated with the TSAA+ scenario implementations.

5.1 ANSPs costs

No additional costs may occur for ANSPs.

5.2 Airport operators costs

No additional costs may occur for Airport operators.

5.3 Network Manager costs

No additional costs may occur for Network Manager.

5.4 Airspace User costs

- Equipage cost
- Cost of operating / maintaining it
- Potential training cost

5.4.1 Airspace User cost approach

To be provided for V2.

5.4.2 Airspace User cost assumptions

To be provided for V2.

5.4.3 Number of investment instances (units)

Not applicable for V1 phase.

Scheduled Airlines Mainline / Regional		Business Aviation (BA)		General Aviation (GA)		Military (MIL)		Rotorcraft (R)	
Ground locations (e.g. FOCs)	Airborne (air vehicles)	Ground locations (e.g.	Airborne (air vehicles)	Airborne IFR vehicles	Airborne VFR vehicles	Ground locations	Airborne (air vehicles)	Ground locations	Airborne (air vehicles)
N/A	N/A	N/A	N/A	Cost per a/c	Cost per a/c	N/A	Cost per a/c	N/A	Cost per a/c

Table 5: Number of investment instances - AUs

5.4.4 Cost per unit

Not applicable for V1 phase. In the following table is defined only where the investment is expected. Cost per unit are not defined.

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Cost category	Scheduled Airlines Mainline / Regional		Business Aviation (BA)		General Aviation (GA)		Military (MIL)		Rotorcraft (R)	
	Ground locations (e.g. FOCs)	Airborne (air vehicles)	Ground locations (e.g. FOCs)	Airborne (air vehicles)	IFR	VFR	Ground	Airborne	Ground	Airborne
Pre-Implementation Costs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Implementation costs	N/A	N/A	N/A	N/A	Cost per a/c	Cost per a/c	N/A	Cost per a/c	N/A	Cost per a/c
Operating costs	N/A	N/A	N/A	N/A	Cost per a/c	Cost per a/c	N/A	Cost per a/c	N/A	Cost per a/c

Table 6: Cost per unit – AUs

5.5 Military costs

There will be the same type of costs like for GA/R and Military (e.g. equipage cost, cost of operating and maintaining it, and potential training cost), however, **Military costs are expected to be much higher than cost for GA**. Especially equipage cost since installations (like fighter aircraft) are much more complex and have to fulfil much higher MIL-standards. This cost may vary across the different types of aircraft types and even for the same aircraft type operated by different nations.

5.6 Other relevant stakeholders

5.6.1 National governments / administrations & organizations

- Expenses in terms of co-financing of R&D work
- Less NMAC and MAC, less time spent o analysis of accidents leading to decreased costs related to investigations.

5.6.2 Airborne industry

Direct cost

- Development cost

Without the costs and investment, it is not possible to create a final product TSAA+ for the customer. All this costs is not relevant for CBA analysis, because in the final result Airborne industry will make a profit. Input costs are indispensable for the manufacture in the sense of commercial business.

6 CBA Model

First, less detailed CBA Model will be developed in V2 phase.

6.1 Data sources

It is expected that following possible data sources will be used for CBA modelling:

- Performance Review Body Publications, e.g. Performance Review Reports
- STATFOR Traffic Forecasts: 2012-2035 IFR Traffic Forecast (Task 4 of the Challenges of Growth 2013)
- Standard Inputs for EUROCONTROL Cost Benefit Analysis (latest version Edition 7, November 2015 – updated bi-annually) Military Fleet Statistics (produced annually by EUROCONTROL)
- BADA (Base of Aircraft Data) – EUROCONTROL
- ESSIP Reports on the progress in implementation of European Single European Sky Objectives – EUROCONTROL/SESAR/EC (updated annually, latest Edition 2013)
- EASA RMT0679 Final Report (Dec 2017)

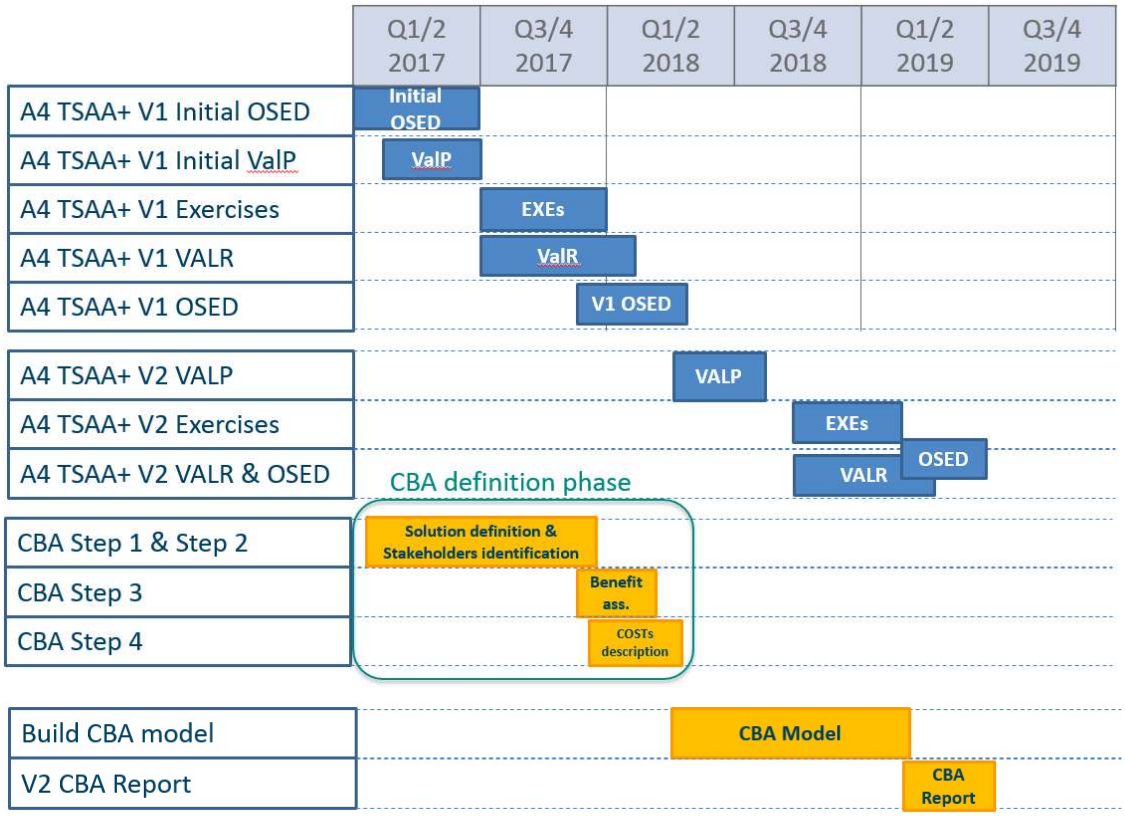
7 CBA Results

First quantification of the CBA results will be developed in V2 phase.

8 Sensitivity and risk analysis

More detailed CBA Model with sensitivity and risk analysis will be developed in V3 phase.

9 Recommendations and next steps



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

[4] CBA Quality Check-List

10.2 Reference Documents

[5] Common assumptions for CBAs as maintained by Pj19 (provisionally the ones included in the 16.06.06- D68_Part 1, New CBA Model and Methods 2015, Edition 00.01.01 can be used)

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

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

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

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

[10]ACAS X CONOPS, V2, FAA, 18 April 2013

[11]PMP PJ11, Ed. 01.00.02, 31 March 2017

[12]European Drone Outlook Study, SESAR, November 2016

(http://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf)

[13]SESAR, ATM CBA for Beginners, Edition 00.01.00

10.3 Other References

[14]EATMA, dataset , 16 January 2017

11 Appendix

Mapping between ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs, Focus Areas and KPIs, source reference *[8]*

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 CO2 emissions			(FEFF2)	CO2 Emissions
Safety	PA9 - Safety improvement by a factor 3-4	Safety	Accidents/incidents with ATM contribution	<SAF1> see section 3.4	Total number of fatal accidents and incidents
Security	PA10 - No increase in ATM related security incidents resulting in traffic disruptions	Security	Self- Protection of the ATM System / Collaborative Support	(SEC1)	Personnel (safety) risk after mitigation
				(SEC2)	Capacity risk after mitigation
				(SEC3)	Economic risk after mitigation

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
				(SEC4)	Military mission effectiveness risk after mitigation

[15] **Table 7: Mapping between ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs, Focus Areas and KPIs**

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