Consulting services for the elaboration of Cost Benefit Analysis and the Business Case for the DANUBE FAB functional airspace block covering the airspace of the Republic of Bulgaria and the airspace of Romania

Cost Benefit Analysis - Final Report

ALG TRANSPORTATION INFRASTRUCTURE & LOGISTICS

europraxis

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1 Executive Summary

This document presents the final results from the DANUBE FAB Cost Benefit Analysis in terms of input values used, results obtained, main assumptions made, Cost Benefit mechanisms, references and methodology employed.

The timeframe for the analysis is the period 2008 to 2030. The pre-implementation period is considered starting in 2008, i.e. a time at which first results and figures were obtained supporting the decision to proceed further with the project, up to December 2012 when DANUBE FAB operations are foreseen to start. The operational period spans the 18 years from 2013 to 2030. Notwithstanding the high probability of continuation of DANUBE FAB operations beyond 2030, the high uncertainty on the forecasts obtained by projecting data beyond 2030 makes it unreliable to extend the analysis beyond this limit.

The monetary impact of DANUBE FAB on stakeholders is quantified by analyzing the FAB implementation economical and operational elements through a modelling approach, which considers two business models: One for external stakeholders (airlines) and another one for internal stakeholders (ANSPs). These two models have been specifically developed for the purpose of this analysis, based on the European MOdel for ATM Strategic Investment Analysis (EMOSIA).

The core of these models is constituted by five Benefit Initiatives into which the monetary impact of DANUBE FAB has been categorized:

1. Airspace design & management and common operational concept: this will bring benefits in terms of ATCO productivity for ANSPs and flight efficiency to Airspace Users;
2. Harmonized training system: implying a reduction in the costs for ATCO initial training for both ANSPs;
3. Harmonized management systems for Safety, Quality, Security and Environment (SQSE): this will bring benefits in terms of staff productivity;
4. Common CNS strategy: enabling an rationalisation of the technical CNS infrastructure deployment on the whole DANUBE FAB territory, thus enabling a avoiding cost duplications
5. Common procurement: closely related to the development of a common CNS strategy and bringing benefits thanks to economies of scale in the procurement of assets and services.

Each Initiative is described by the use of an associated benefit mechanism which details the cause-effect relationships between activities, operational impacts and monetary impact according to specific KPAs and for each benefit initiative. The main inputs available from parallel deliverables produced within the DANUBE FAB project have been augmented by experts from BULATSA and ROMATSA, according to their experience and related Working Group. The elaboration of these inputs has been undertaken in order to assign monetary values to operational impacts and the results have been analysed and validated through an iterative process involving at each of the three cycles both a team of independent experts in ATM economics and the DANUBE FAB WG experts, in accordance to the requirements set by EC regulation 176/2011. Also Airspace Users have provided their comments and feedback on the data and assumptions used in the model, which have been discussed during a Workshop and fully integrated in the latest version of the analysis.

The principal focus during the development of the DANUBE FAB has been to re-design airspace, taking due account of collaborative processes, at the international level regardless of existing boundaries. The result is a more efficient route network with significant savings to be realised by airspace users. The re-designed airspace and optimised route network has been developed by a specifically tasked DANUBE FAB Airspace Design and Operations Development Expert Group (ADODEG) with the support of EUROCONTROL. ADODEG comprises civil and military operational experts from both Member States and is responsible for development and evaluation of DANUBE FAB operational concept and airspace improvements.

The route network is in-line with the European ATS Route Network Version-7 (ARN v.7) and the basic structure of airspace has been defined to minimise coordination and increase capacity for an acceptable amount of workload. Being in accordance with the European ATM Master Plan, the route network provides an optimal air traffic flow and is fully compatible with and the Single European Sky (SES) regulatory framework. During the design phase several variants were simulated in real time in one of the most complex simulations ever undertaken within EUROCONTROL and clearly demonstrated the feasibility and safety of full implementation.

The result is 95 new and dedicated DANUBE FAB routes, 88 of which are currently agreed for implementation. These routes have been developed throughout the lifetime of the FAB project and they will continue to evolve through the ADODEG group. 41 routes have already been implemented, and a further 26 will be implemented in stages between now and 2020. The remaining 21 other routes are currently planned to be implemented after 2020, though they may be implemented earlier or not at all because of a plan to move to Free Routes across the entire FAB airspace around 2020. The Free Route Airspace final date of implementation for all operations will follow the step implementation of night free route operations and will depend on the success of implementing the Free Route concept at European level. This will begin with the implementation of free route at national level in the summer of 2014, and then at a FAB level, in the summer of 2016.

The impact on Airspace Users will be seamless flight operations conducted within the DANUBE FAB Airspace, providing more routing options and more efficient in terms of flight distance, providing savings in terms of flight time, fuel and CO_2 emissions. Input data available from DANUBE FAB Fast Time Simulations have been used in this study to provide results in terms Net Present Value. Airlines experience significant economic benefits since the beginning of the FAB operations, thanks to the enhanced flight efficiency permitted by the optimized DANUBE FAB route network, without any upfront investment neither added operational costs required.

On the other hand the ANSPs will be able to exploit synergies, share resources, avoid cost duplication and optimize service provision according to the five Benefit Initiatives being implemented in the context of the FAB. The breakeven point for ANSP is in 2017, due to the initial investments required for the design, implementation and deployment of the operational improvements and associated procedures introduced by the FAB Operational Concept. These are later outweighed by improved cost-effectiveness through cost avoidance in several areas thanks to cooperation between ANSPs and harmonization of several functions.

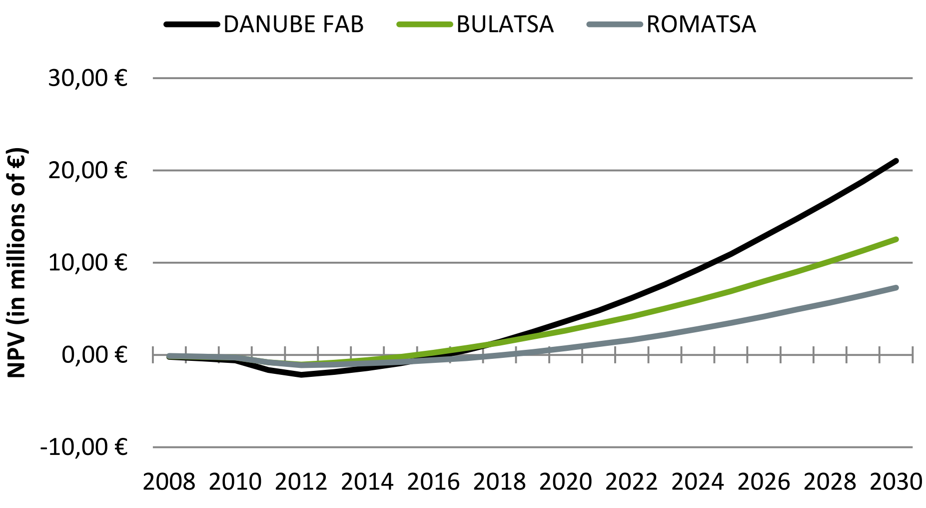

Figure 1: Overall DANUBE FAB ANPs NPV

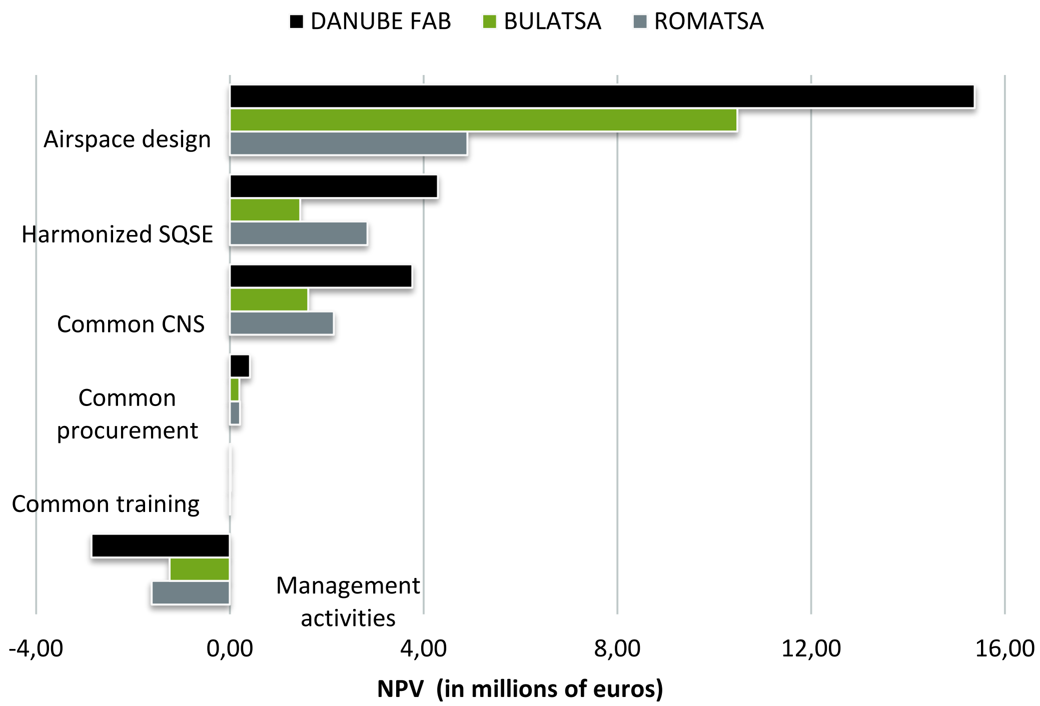

Figure 2: DANUBE FAB NPV distribution

For ANSPs, Figure 1 shows that the **NPV for all initiatives is 12,5 M€ for BULATSA and 8,5 M€ for ROMATSA for a total of 21,0 M€**. The DANUBE FAB implementation has a very positive added value with a short break even point in 2017. The main contribution on the NPV is due to “Airspace design & management and common operational concept”, followed by “Harmonized SQSE system”. The benefits are mainly due to the increase in ATCO productivity that leads to reducing the needs for hiring new ATCOs in the future (and also the related training), and to the establishment of a SQSE joint pool due to a similar mechanism of increase of productivity of the personnel. “Common CNS Strategy” brings benefits in terms of reduction in capital and operational cost with respect to the Baseline scenario, in which a National strategy is applied. “Common procurement” and “Harmonized training” have a lower economic impact, since the activities assumed to be undertaken in these areas have been limited to the ones already agreed by the two ANSPs.

The uncertainties impacting most the ANSPs NPV are the ones related with the initiatives bringing most benefits, i.e. the number of new ATCOs and SQSE staff avoided thanks to the increased productivity enabled by the establishment of FAB, as shown in the following Tornado diagram.

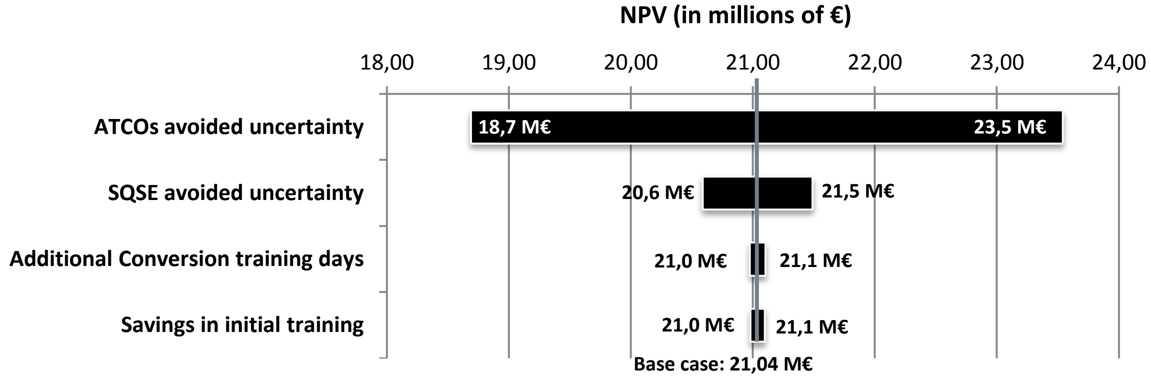

Figure 3: DANUBE FAB tornado diagram

Notwithstanding the considerable impact that uncertainty plays on the final output value, this continues to be positive even in the worst case scenario considered. Besides the tornado diagram in Figure 3 which shows the impact of modification of one uncertain variable at a time, Table 1 presents the NPV variability resulting by considering three different situations:

- Worst case scenario: all the uncertainties assume the lowest value in their distribution at the same time
- Nominal scenario: all the uncertainties assume their base values, this coincide with the results presented in the report
- Best case scenario: all the uncertainties assume the highest value in their distribution at the same time

Scenario	Discount rate 4%	Discount rate 8%
DANUBE FAB	NPV in M€	
Best case	24,1	12,2
Nominal	21,0	10,6
Worst case	18,1	9,1

Table 1: Uncertainties impact on ANSPs

Scenario	Discount rate 4%	Discount rate 8%
DANUBE FAB	NPV in M€	
Best case	821	446
Nominal	570	312
Worst case	360	200

Table 2: Uncertainties impact on Airlines

Under all these scenarios for uncertainty the DANUBE FAB is expected to bring a positive added value to ANSPs and the same general consideration applies to Airspace Users.

For external stakeholders, Figure 4 shows that the **NPV gives an added value of 570 M€** for Airlines and shows the positive added value implied by the DANUBE FAB operational improvements.

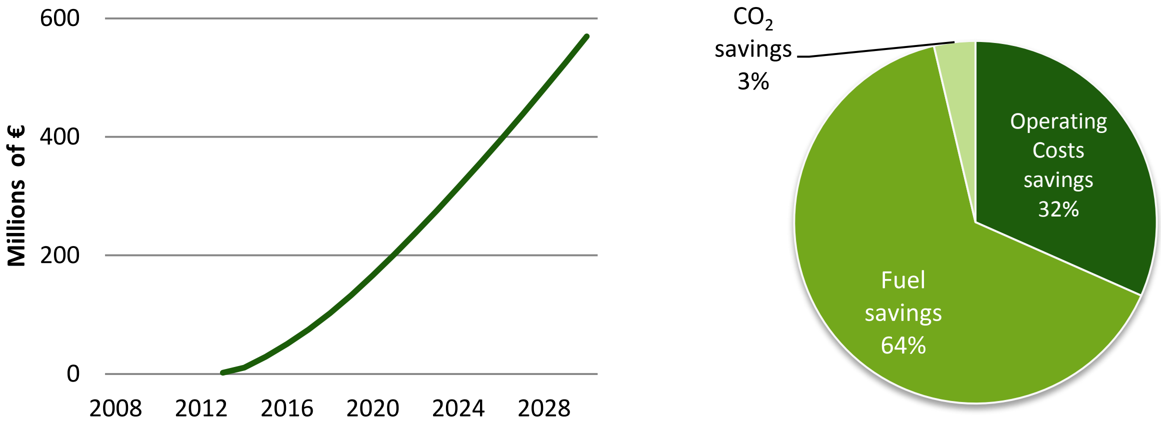

Figure 4: Airlines NPV

Figure 5 shows the tornado diagram explaining the impact of modifying one uncertain variable at a time on the final NPV for Airspace Users. The uncertainties impacting the NPV in a greatest extent are the initial Fuel Costs and the Flights impacted followed by Direct Operating cost and CO_2 cost.

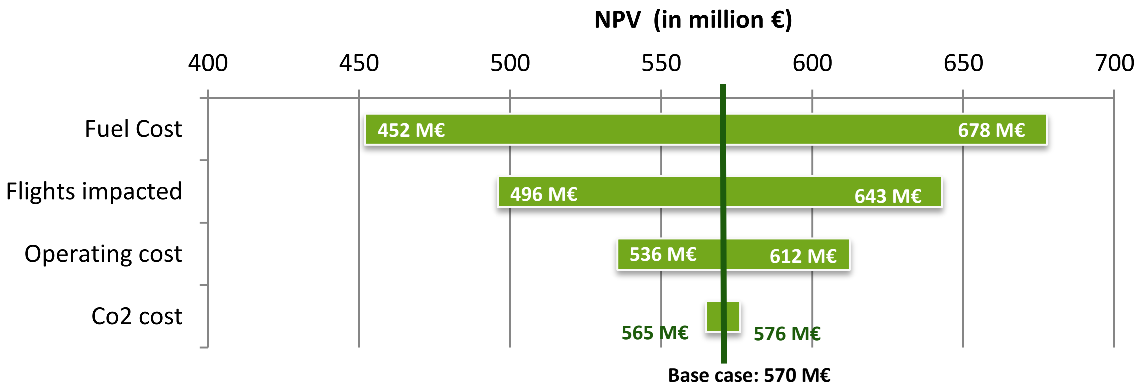

Figure 5: Sensitivity of the NPV to the uncertainties in the model

The rest of this document unfolds as follows:

- Section 2 gives an overview of the study in terms of objectives, scope, assumptions and overall framework.
- Section 3 provides an analysis of the current situation including operational, economic and financial cost effectiveness for the two ANSPs.
- Section 4 details the methodology applied to develop the Airline and the ANSP models.
- Section 5 presents the results from the analysis.
- Section 6 summarizes the high-level conclusions of the study.
- Section 7 collects the reference documents used.
- Section 8 provides details on the matching between applicable regulatory documents and the study as well as details of calculations.

2 Introduction

The establishment of the DANUBE FAB implies two main types of impacts:

- the internal costs and benefits experienced mainly by the two ANSPs operating within the scope of DANUBE FAB, i.e. ROMATSA and BULATSA;
- the external costs and benefits impacting external stakeholders as an effect of the establishment of DANUBE FAB.

The present document consists of a Cost Benefit Analysis determining the internal and external economic and financial impacts of the establishment of DANUBE FAB in a quantitative manner, i.e. expressed as monetary costs and benefits.

Commercial Airlines have been retained as the category representative of external stakeholders to be included in this release of the CBA, since they represent the principal DANUBE FAB Airspace Users and they will experience most of the benefits derived from the establishment of the FAB.

Other stakeholders (General Aviation, Airports, NSAs, and the Militaries) will be only partially affected by the establishment of the FAB and hence a qualitative assessment has been conducted to assess the impact on them, included in the Business Case Report [23].

2.1 Rationale for the study

The European airspace is among the busiest in the world with over 33,000 flights on busy days and airport density in Europe is very high. Furthermore the fragmentation in the European ATM and CNS system fragmentation appears to be a major factor in reducing ATM performance and is causing a consistent performance gap with respect to the US ATM system [24]. Each time an aircraft enters a country's airspace, it is serviced by different ANSP, according to different rules and operational requirements. This affects safety, limits capacity and adds to the cost of flying.

The EU Single European Sky (SES) initiative was instigated to overcome this fragmentation and capacity limitation by structuring airspace and air navigation services at a pan-European level. The SES program undertaken by the European Union represents a legislative approach aimed to meet future capacity and safety needs at a global European level rather than at local one, with the objectives of restructuring the European airspace as a function of air traffic flows, creating additional capacity and increasing the overall efficiency.

Within the SES framework, Member States of the European Union (EU) are required to establish Functional Airspace Blocks (FAB) by 4 December 2012 [25], i.e. volumes of Airspace based on operational requirements and established regardless of State boundaries, where the provision of air navigation services and related functions are performance-driven and optimized with a view to introducing, in each functional airspace block, enhanced cooperation among air navigation service providers or, where appropriate, an integrated provider.

The DANUBE FAB initiative is aimed to ensure compliance with the EU Single European Sky legislation. The Bulgarian and Romanian ANSPs (respectively BULATSA and ROMATSA) have been cooperating since 2004 to enhance cooperation in the ATM/ANS domain, creating the prerequisites for the establishment of a FAB [26]. This cooperation has led to a series of activities commonly executed to identify and fulfil the prerequisites of the FAB, organized under a FAB Working Group comprising experts from both ANSPs.

The main benefits of the DANUBE FAB project will be the enhanced efficiency and safety of flights and the reduced flying time, achieved through more efficient trajectories and the improved capacity of the airspace of both States. The DANUBE FAB area is to be considered and structured as one single continuum airspace, across its geographical area within which provision of ATS is not constrained by national boundaries/ FIR borders.

The Republic of Bulgaria and Romania need to ensure that the reorganization of their own ANS provision takes place in an efficient way from an economical point of view, bringing benefits to both the service providers and to its customers, with favourable impact on all stakeholders and in the country on the whole. Given the current situation and the future challenges that the Air transportation sector faces, it is of key importance that the investment on a FAB is fully consistent with the evolution of the economic environment and that the investment strategy is coordinated with the expected revenue rates.

Furthermore the European Commission regulation No 176/2011 (i.e. the FAB implementing rule) implies that all Member States having agreed to establish a FAB shall provide specific information to the European Commission no later than 24 June 2012. Among the different pieces of information to be provided there is the documentation supporting and demonstrating the FAB overall added value based on cost-benefit analyses.

The Phase 2 of DANUBE FAB project identified the need to conduct a sound Cost Benefit Analysis (CBA) and Business Case (BC) to support the informed decision making by all involved stakeholders. This document represents the first product resulting from these needs, focusing on the internal and external financial impacts in terms of costs and benefits of DANUBE FAB establishment, respectively on the ANSPs and on the Commercial Airlines.

2.2 Objectives of the Analysis

The DANUBE FAB Cost Benefit Analysis together with the Business Case, assess the impact directly implied by the establishment of the DANUBE FAB on the involved stakeholders, in order to:

1. provide an individual view of the impact of the establishment of the DANUBE FAB on the civil and military airspace users;
2. demonstrate the individual positive financial result (expressed as Net Present Value) for Airspace Users for the establishment of the DANUBE FAB;
3. demonstrate that the implementation of the DANUBE FAB contributes to a reduction of the aviation environmental impact;

To fulfil these objectives this CBA provides numerical figures to assess what are the potential benefits for ANSPs and Airlines in terms of economic value created by the establishment of DANUBE FAB and what will be the disadvantages in case it is not created.

The Business Case is developed in a separate document to complement and extend the numerical results of the CBA, through a wider qualitative analysis including the overall performance impact on all impacted stakeholders.

2.3 Approach to the analysis

A preliminary analysis of the current situation regarding ATS delivery in both Countries is presented, since it depicts the current context and is propedeutic to the identification of the areas in which benefits can be realized thanks to the establishment of the DANUBE FAB. The analysis then is built around a number of benefit initiatives described as DANUBE FAB common functions in [5]. These common functions have been partially re-organized and merged for the CBA, in order to avoiding costs/benefits double counting. Airspace design & management and common operational concept have been merged in the CBA, since they are highly dependent and overlapping areas.

A modelling structure is adopted which allows to set up a methodology to analyse quantitatively each Benefit initiative and associated benefit mechanism, by calculating expenses and benefits due to DANUBE FAB. Only the specific costs and benefits stemming from these initiatives have been quantified with respect to the baseline scenario representing the BASELINE option, according to the “delta” approach. The timeframe 2008-2030 has been taken for all scenarios, as considered representative of the overall impact deriving from FAB establishment, including pre-implementation costs and the longest benefit lags.

The analysis tackles separately the economical impacts on Airlines on the one hand and on ANSPs on the other one, by working on independent models and benefit mechanisms. Models are based on the European MOdel for ATM Strategic Investment Analysis (EMOSIA), which provides a reference framework for conducting Cost Benefit Analysis in ATM. The standard EMOSIA models have been modified and adapted to fit in the context of DANUBE FAB.

The input data used for assessing the DANUBE FAB options for implementation have been derived from the most-updated references resulting from the main deliverables produced during previous and current Phases of DANUBE FAB study. Specific input figures regarding potential future FAB impacts in terms of costs, benefits and time variables not available in any reference document have been estimated by DANUBE FAB experts, through a structured analytical process. The uncertainty around these estimations has been provided by assigning three different values based on the expected probability of outcome the event: High (10% chance that the outcome is higher than the defined value), Base (50/50) and Low (10% chance that the outcome is lower than the defined value). This allows to include in the analysis different possible values for variables affected by uncertainty (mainly due to their future realization) and to analyse their impacts on the final results through a sensitivity analysis.

The complete set of assumptions, the reference input data and the cost-benefit mechanisms are documented in this report, with the aim of providing the maximum level of transparency on the methodology and steps applied to produce the results.

2.4 Time horizon

The time horizon included in the analysis spans from 2008 to 2030, in line with the Phases of the DANUBE FAB project.

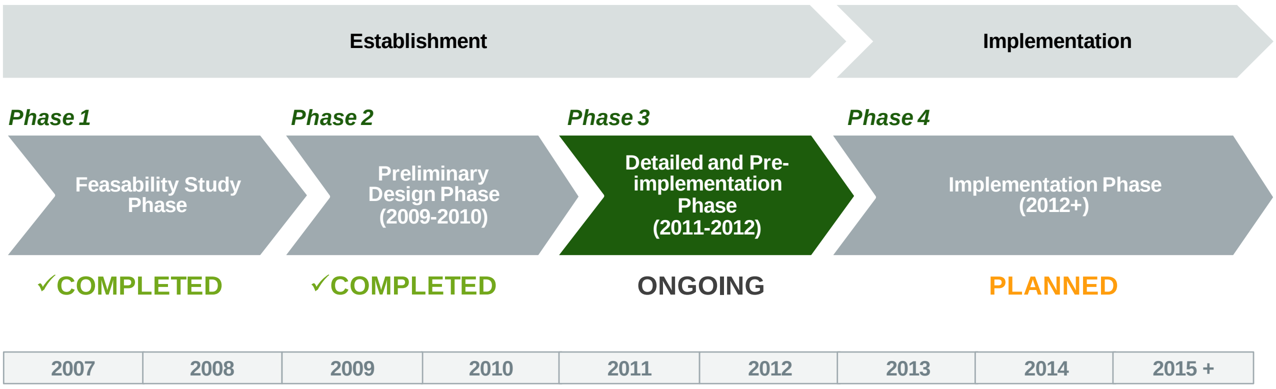

Figure 6: DANUBE FAB Project Phases

The pre-implementation period is considered from 2008 (time when first results and figures were obtained supporting the decision to proceed further with the project) up to December 2012 when DANUBE FAB operations are foreseen to start.

The DANUBE FAB operational period considered for the CBA spans the 18 years from 2013 to 2030. Notwithstanding the high probability of continuation of DANUBE FAB operations beyond 2030, the high uncertainty on the forecasts obtained by projecting data beyond 2030 makes it unreliable to extend the analysis beyond this limit.

2.5 Geographical scope

The DANUBE FAB covers the airspace Bulgaria and Romania. It is organised in two Flight Information Regions (FIRs) - Bucharest and Sofia.

The air navigation services within DANUBE FIR will be provided from the two ACCs - Bucharest ACC and Sofia ACC, located in Bucharest and respectively in Sofia.

The TMA as well as airport operations are not included in this analysis, in line with the assumption made in the Environmental Assessment [4]. This implies that the geographic scope of the assessment would be limited to the significant impacts arising from changes to en-route aircraft operations resulting from the FAB proposals.

2.6 Scenarios

Two scenarios have been included in the analysis, with the objective of making a direct comparison between them according to the “delta approach” applied.

2.6.1 FAB scenario

This scenario represents the partial integration option retained for DANUBE FAB out of the Preliminary Design Phase. It is characterized by the existence of the two services providers, which maintain their legislative and financial independence working together in several areas for harmonisation and cooperation.

In particular the re-design of airspace occurs regardless of existing boundaries and based on a collaborative process regardless of existing boundaries. The result is a more efficient route network with significant savings to be realised by airlines. The re-designed airspace and optimised route network have been developed by a specifically tasked DANUBE FAB Airspace Design and Operations Development Expert Group (ADODEG), comprising civil and military operational experts from both Member States with the support of EUROCONTROL.

The result is 95 new and dedicated DANUBE FAB routes, 88 of which are currently agreed for implementation. These routes have been developed throughout the lifetime of the FAB project and they will continue to evolve through the ADODEG group. 41 routes have already been implemented, which are not considered within the FAB scenario due to the fact that the timing for their implementation was outside the implementation phase. The further 26 changes that will be implemented in stages between now and 2020 have been considered to be introduced gradually into operations implying a linear realization of benefits. The remaining 21 other routes are currently planned to be implemented after 2020, though they may be implemented earlier or not at all because of a plan to move to Free Routes across the entire FAB airspace around 2020. The assessment proposals originally considered the inclusion of any Operational Improvement as an input to the defined route network. Free Route Airspace in the larger FAB airspace will be more efficient than that, that could be implemented in one constituent State only, but there is no reason why FRA would not have been implemented within each State without FAB implementation. A comparison of these two situations would reveal the full benefits of the FAB as stated in [4].

On the other hand the ANSPs will be able to exploit synergies, share resources, avoid cost duplication and optimize service provision according to the different initiatives being implemented in the context of the FAB.

2.6.2 The baseline scenario

The baseline scenario represents the situation as if nothing is done for the DANUBE FAB implementation and each State follows the Business-as-usual approach to the provision of ATS within Airspace under its responsibility. This implies that a State oriented approach is undertaken to implement:

- airspace & network design;
- FUA application;
- deployment of CNS infrastructure;
- all the others initiatives not directly dependent on the FAB are included: SESAR, ESSIP, etc.

This scenario is used as a baseline to calculate all the additional costs and savings achieved in the other scenario, i.e. the FAB scenario. As mentioned in the description of the FAB scenario, the exact allocation of initiatives and related benefits between the baseline and FAB scenario is in some cases difficult to do, due to the long lasting cooperation activities undertaken by both DANUBE FAB partners which have already brought some benefits, even before the start of FAB operations. It is considered however that the DANUBE FAB study framework and the existence of related binding requirements created the necessary momentum for most of the initiatives to be realized, that could not have been possible due to the complexity R&D activities required beforehand.

2.7 Stakeholders involved

Following analysis and discussions with experts from BULATSA and ROMATSA, it was concluded that the stakeholder categories experiencing direct economic impact from the establishment of DANUBE FAB are:

- The two ANSPs involved, i.e. ROMATSA and BULATSA. They will experience the internal benefits deriving from all the activities performed in common functions, while on the other hand bearing the costs for their realization (pre-implementation, one-off, operating and capital)

- The DANUBE FAB Airspace users, mainly represented by commercial airlines operating flights through the FAB Airspace. They will directly experience the external benefits generated by the new DANUBE airspace design and management, irrespective of national borders and the harmonized procedures established in the common FAB operational concept. No specific cost is considered attributable to the DANUBE FAB establishment, neither for equipment since no airborne system is necessary to fly DANUBE FAB, nor for additional manpower.

Both categories of stakeholders were involved into the CBA development process. Experts from ROMATSA and BULATSA involved in the DANUBE FAB Working Groups were consulted at different stages of the study, first to provide estimations of input data and related uncertainties and then to iteratively validate the assumptions and results. The Airspace Users were presented with mature results and provided a constructive feedback during a Workshop held in Bucharest in April 2012. The feedback obtained during this meeting, mainly regarding the structure of operating costs for airlines and how to deal with uncertainty, has been integrated into the CBA model and included in this final version of the CBA, in fulfilment of requirements stemming from EC Reg. 176/2011.

Other stakeholders are impacted but the impact is more qualitative than quantitative, i.e. it realizes mostly in terms of enhanced quality of service thanks to harmonization of working methods and procedures:

- Military ANSP and Airspace Users: A joint civil-military coordination process will ensure consistency between the planning and utilisation of airspace and route networks in relation to the planning and use of airspace required for military activities. This will bring enhanced efficiency in the management and allocation of Airspace but on the other hand will imply a cost resulting from additional effort and resources required by new forms of cooperation, collaboration and coordination processes plus administrative procedures both at national and FAB governance levels.

- National Supervisory Authorities: The main impact is the establishment of a solid cooperation framework, implying more consistent and harmonised supervision in the FAB, which could improve the effectiveness and efficiency of supervision in a FAB vs. the pre-FAB situation. On the other hand it will certainly imply an inevitable impact resulting from additional effort and resources required by new forms of cooperation, collaboration and coordination processes plus administrative procedures at NSA and FAB governance levels.

- General Aviation: Equitable access to airspace will be guaranteed to all categories of users through a collaborative airspace planning process set up at strategic level between civil and military units. No additional cost is required to comply with specific FAB requirements.

- Airports: Some modification in the approach flight profiles could be envisaged, in case of modification of interfaces between lower and upper routes. This could bring some benefits in terms of noise impact in the areas surrounding airports, but there are no specific elements to assess this impact for the time being. No specific additional cost for Airports is considered attributable to FAB establishment at the current stage of advancement.

2.8 Basic assumptions and data used

Data sources containing relevant data for this CBA in the form of past and forecasted operational and economical figures are many and diverse. Data associated uncertainty increases for longer term data, reducing its degree of reliability. Due to this complex and diverse data structure upon which the CBA is based on, a set of general assumptions needs to be taken in order to preserve consistency and soundness of the study. The following list of assumptions is provided as a high level checklist for the sake of transparency. Additional considerations impacting more detailed calculations are progressively introduced over the document as appropriate.

1. Traffic forecasts: the traffic forecast figures have been taken from STATFOR medium term forecast [2] for the period 2005 to 2017 and from STATFOR long term forecast [3] for the period 2018-2030.

2. Baseline case: the baseline scenario has been considered representing the situation as if nothing is done for the DANUBE FAB implementation (Business as usual). All the others initiatives currently ongoing or that will be implemented in the future have been taken into account: SESAR, ESSIP and

all other initiatives not directly dependent on the FAB. This scenario has been used to calculate all the additional costs and savings achieved in the FAB scenario, according to a “delta” approach.

3. The baseline figures have been estimated by expert judgment from ROMATSA and BULATSA and based on references such as the EUROCONTROL ACE report 2010, LSSIP, National Performance Plans, SESAR Definition Phase deliverables, previous or parallel DANUBE FAB studies, etc. The list of reference documents is provided in the references section.

4. FAB scenario: It represents the partial integration option retained for DANUBE FAB out of the Preliminary Design Phase (Phase 2: 2009-2010). It is characterized by the existence of the two services providers, harmonisation and cooperation in several areas. For the purposes of this CBA, this scenario has been created as a modification of the baseline (i.e. as a delta scenario) according to the FAB common functions described in [5] and detailed through other supporting documents from the previous or current DANUBE FAB study phases.

5. Time frame for the CBA has been taken from 2008 to 2012 for the pre-implementation phase and from 2013 to 2030 for the implementation one.

6. Stakeholders: the main stakeholders included in the CBA are the two involved ANSPs (ROMATSA and BULATSA) and the commercial Airspace Users (i.e., commercial airlines). No specific capital investment has been considered for the latter category attributable to FAB creation, but just important benefits stemming from improved flight efficiency. Qualitative assessment of the impact of the FAB on other stakeholders will be included in the Business Case, since it has been identified that they will experience qualitative more than quantitative benefits, without suffering any costs from the FAB implementation.

7. Inflation: All figures are in real terms, taking into account different inflation values from Romania and Bulgaria as published in [6] up to 2015 and assuming a flat rate equal to the 2015 value, afterwards. Further information in this respect is provided section 4.

8. For airlines, the impacted operating cost is an increasing function of time, following an annual growth rate consisting of an uncertainty range set between a lower band equal to 0% and an upper band articulated according to national inflation rates of the different DANUBE FAB operating airlines. Further information in this respect is provided in section 4.2.6.1.

9. ATCO costs: no additional ATCOs have been considered necessary due to the FAB scenario. The increase in ATCO numbers occurs both in the baseline and FAB scenarios, with a lower slope in the FAB. In fact, thanks to the Common Operational concept delivering higher capacity, avoidance of new ATCOs staff employments has been estimated by experts for mid to long term.

10. Salary costs for ATCO staff are assumed to increase by 1% over inflation, in line with assumptions in SESAR D4.

11. Technical support costs: No additional Technical Support Staff have been considered necessary due to the FAB scenario. Technical support costs are assumed to remain stable.

12. Administrative Staff: No Administrative staffs have been considered necessary due to the FAB scenario.

13. FAB pre-implementation costs have been extracted from the figures provided by ROMATSA and BULATSA correspondent to the direct costs per Working Group from 2008 to 2012. Figures provided have been divided by 2 to account only the impact on ANSPs (these costs were financed at 50% by

TEN-T funds). The costs in 2008 contain mission costs and procurement for one external consultancy study; the costs from 2008 to 2010 are final audited, for 2011 are final not already audited, the costs for 2012 are budget figures.

14. The unit rate decrease due to the DANUBE FAB implementation was not included in the airline model as a saving but ANSPs savings per Service units and savings per flight are provided in the results section 5.2.4.

3 Description of the Context

This section introduces a description of the current situation, upon which the DANUBE FAB will become operational. It consists of a factual analysis of the existing airspace configuration, facilities and services in both Countries and of the main performance indicators registered by each ANSP before the implementation of the DANUBE FAB. Also a number of looking forward activities and projects planned by each State is reported, according to the LSSIP information, thus allowing to outline the framework for description of the Baseline scenario, according to which no FAB is implemented and each ANSP continues working according to the business-as-usual option. This analysis is intended to identify the areas for absolute and comparative advantages existing for each ANSP and within the FAB region as a whole, stemming from the creation of the DANUBE FAB.

3.1 Airspace Design and Management

The airspace coinciding with the DANUBE FAB area is currently organised in 2 FIRs: Bucuresti and Sofia which cover the whole area of responsibility for the provision of ATS in DANUBE FAB. Each State has its own ACC, whose boundaries are mainly aligned along national borders. This results from the traditional State oriented approach to airspace design and operational concept, possibly creating constraints to ATS routes and sectors affecting the efficiency of the ATM system. The interface between Romania and Bulgaria is estimated to contribute to a 0,5% of route extension with respect to the great circle distance between the entry and exit point in the FAB [24].

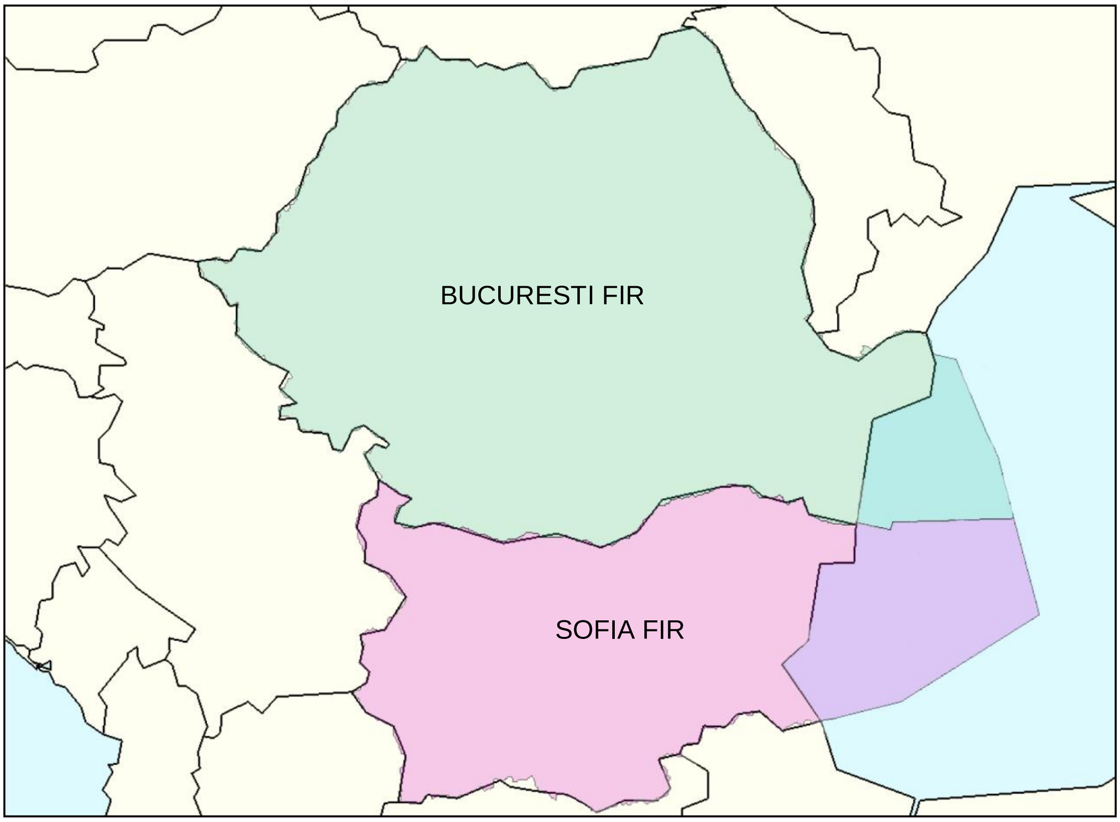

Figure 7: Existing FIRs within the DANUBE FAB Area [24]

The main characteristics of the current airspace structure within the DANUBE FAB area are drawn from [20] presented below.

- High Seas area: Black Sea area portions are assigned under air navigation regional agreements to Romania and Bulgaria. Any ATS route network modification over High Seas shall be subject to formal amendment procedure of European Air Navigation Plan.

- Airports and TMA/CTR: 23 airports and 1 heliport (most of them used by IFR/VFR traffic). 6 TMAs (Burgas, Sofia, Varna, Bucharest, Constanta and Arad), of which the busiest ones are Bucuresti and Sofia. These are not however representing a bottleneck nowadays.
- ATS route network structure and airspace organisation: main orientation of ATS routes is NW to SE and vice-versa connecting Central Europe/UK with Turkey, Middle East and beyond and linking the Middle East to en-route traffic arriving/departing in the European region; and secondary are Central Europe/UK – Far East, Northern Europe – Greece/Africa, Russian Federation – Mediterranean area. There are no unnecessary RAD restrictions.
- ACC sectorisation and capacity: boundaries aligned with national borders, 27 en-route sectors at maximum configuration. A global evaluation (influenced by costs and available capacity after CFMU intervention/regulation) does not predict significant structural shortfall in terms of capacity for a medium growth traffic forecast and a summer peak day (Ref. NOP). The DFL between different layers in most commonly used configuration is FL335 within Romania and FL355 within Bulgaria, influencing coordination procedures between sectors.
- Military activity, TRAs, TSAs and CDRs: Both states have established AMCs (Bucuresti and Sofia) but a LoA is still expected to be signed. All reserved areas are AMC manageable in Bulgaria and in Romania and number of TRAs and TSAs is expected to be redesigned for both. Cross-Border Areas, PCAs and RCAs for flexible airspace management are not established. CDRs generally established through areas identified under “AMC-Manageable Areas”. There are no specific permanent military areas.

In addition to the current airspace structure described above, an operational approach to the current situation description can be given by introducing the Regional Route Network Developments that are being addressed in general in the South-Eastern Europe area. More specifically, the actions taken between Bulgaria and Romania had as main objective to review the route network improvement proposals raised by the States, IATA, IACA, and EUROCONTROL. The implementation of interface improvements between the two states started before the summer season 2009, representing just anticipation first step of the benefits achievable by a common Airspace design within the whole DANUBE FAB area.

3.2 Communication, Navigation and Surveillance (CNS) infrastructure

A brief description of the main CNS infrastructure existing in Bulgaria and Romania is presented in the following, extracted from [22] and presenting the actual technical services in ROMATSA and BULATSA.

ROMATSA’s Voice and Data Communication Network (STCR) provide necessary communications between distant facilities, including ACC room, VHF transmitting/receiving centres and airport towers. It is built using CISCO routers from series 3600, 3800 and 7600, based on IP protocol to transport voice and data. 23 frequencies are allocated to the different sectors, one of which was replaced in 2006 with an 8,33kHz spaced channel, and other 6 are ready to be replaced with 8,33kHz spacing frequencies.

For BULATSA the Telecommunication Network called National Aeronautical Telecommunication Information Network provides the necessary voice and data communication between infrastructure equipment (Radars, VHF radios, MTO, etc) and ACC centres and towers. The number of radiofrequencies for ACC purposes is eleven including seven for family sectors Sofia and four for family sectors Varna. Up to now three 8,33 frequencies for the family sectors Sofia are dedicated.

One CIDIN link is available between Bucharest and Sofia ACCs using the DANUBE FAB communication infrastructure. Until the end 2012/early 2013 the link will migrate to AFTN/AMHS, in correlation with the results of AMHS interoperability tests planned for 2012. The communication infrastructure enables AFTN information, including those necessary for national contingency positions, without the need for additional expenses.

The en-route NAV infrastructure in Bulgaria consists of the network of ground VHF Omnidirectional Range/Distance Measuring Equipment (VOR/DME), one single DME and Non-Directional Beacons (NDB). There are two ongoing activities related to the Navigation services provided by BULATSA CNS directorate. One of them is the application of the signed Agreement aimed at cross-border use of neighbouring Navigation aids with ROMATSA and R-NAV. The other is a DME equipment delivery for BULATSA to provide DME-DME ground infrastructure sufficient for RNAV purposes above FL100 for the most of the

Bulgarian airspace and above FL120 in Southern Western mountainous part of the country. ROMATSA navigation services for en-route are composed by 13 DVOR – DME systems, 3 CVOR - DME systems, 2 DME systems and 17 NDB systems. The implementation of P-RNAV has been completed for ROMATSA.

Regarding the current general situation of Surveillance Systems within Romania, it can be said that ROMATSA's Radar System consists of three Mode S radars, three en-route MSSR radar sites and one co-located PSR/MSSR TMA radar sites. Each distant radar head is connected to a technical plant via radio link and after that, through ROMATSA's own communication system (STcR) and by satellite, the radar data are collected in three Operational Centres (Bucharest, Arad and Constanta).

ROMATSA has concluded radar data exchange agreements with Hungarocontrol, BULATSA and Moldatsa. Based on these agreements ROMATSA receives radar data from Puspokladany, Vitosha, Varbitza and Chishinau MSSR's and provides with radar data from Manastur, Buciumeni and Topolog.

The BULATSA Radar System consists of three en-route radar sites (Vitosha, Varbitsa and Plovdiv) and three TMA radar sites (Sofia, Varna and Burgas)

BULATSA ATM system is based on Selex ATM system architecture (SATCAS) including the

following subsystems:

- FDP System
- ODS System
- SDP - Surveillance Data Processing including ARTAS and RMCDE
- CMS - Control Monitoring System
- Safety Nets
- REC/PLB System
- TDS – Test and Development System
- ATM Simulator
- Backup (Fallback) system

SATCAS system is located in Sofia and is recently extended to cover 2 remote locations – the approach sectors of Varna and Burgas and their respective towers. The Two APP/Tower Control Centres located at Varna and Burgas are configured in order to support the implementation of the "Tight Tower Integration" operational concept, conceived in the frame of the "gate to gate" ATM concepts permitting complete integrated data sharing among all the controlling units supported by the same central processing facilities. The civil-military coordination is performed within the system architecture of the ATM system with additional remote FDA positions, part of SATCAS ATM system, located in military sites. The Air Sovereignty Operations Centre (ASOC) is receiving radar data from all Bulgarian radars. Flight data are transmitted towards military sites through AFTN.

ROMATSA ATM system is based on Selex ATM system including the following subsystems:

- FDP System
- ODS System
- SDP (RDP) - Surveillance Data Processing
- CMS - Control Monitoring System
- Safety Nets
- REC/PLB System
- TDS – Test and Development System

Selex ATM system is distributed in 3 OPS: Bucharest, Arad and Constanta each of these centres including similar subsystems for the above mentioned systems (except FPPS which is located only in Bucharest). The

ROMATSA system for Civil-Military coordination provides the functionalities of sharing of information on flights entering Bucharest FIR, synchronization of the relevant FPL information and management of OLDI messages received for flights with no associated FPL.

3.3 Current implementation of ESSIP objectives

In this section the current situation is described according to the information derived from LSSIP documents reporting on the progresses achieved at national level and giving details on the implementation plans for the common European Single Sky Implementation (ESSIP) objectives over the next five to seven years. In particular the identification of ongoing or planned projects in the ATM domain in Romania and Bulgaria, a brief overview of the co-operation framework in South-Eastern Europe and a list of the objectives that are or may be related to the DANUBE FAB implementation scope are provided based on [18] and [19].

Regarding the current regional co-ordination, in the area of South-Eastern Europe the Memorandum of Understanding for the Establishment of Air Traffic Management Cooperation in South-Eastern Europe (ACE MoU) was signed in Strasbourg on 8 July 2003 by Bulgaria, Romania, Moldova and Turkey, with the overall objective of enhancing collective capacity and general performance of ATM systems in the area. With the aim of enabling the Parties to co-operate among them and with the EU and EUROCONTROL, AUs and other institutions, a second meeting was held in October 2004 but since then no significant progress has been made in the enhancement of ATM co-operation in this area. Therefore, the implementation of the DANUBE FAB stems from this early initiative but including just Bulgaria and Romania as partners.

A number of national ongoing or planned projects identified in the LSSIP documents are also worth being considered in order to depict the context of the DANUBE FAB establishment. The following Table synthesises the information on the main projects having an impact onto operational and technical en-route matters, hence potentially impacted by the establishment of the FAB.

BULGARIA	
Project	**Status / Comments**
SATCAS system upgrade	In progress, planned for 2015
National communication ATM network	In progress, planned for 2013
Improvements of surveillance infrastructure (PSRs & MSSRs)	Planned for 2012
Enhancement of DME/DME coverage	Planned for 2012
ADS-B System	In progress, Planned for 2013
ROMANIA	
Project	**Status**
Transfer the en-route ATC activities from Constanta to Bucharest	Completed
Transfer the en-route ATC activities from Arad to Bucharest	Planned for 2012
Bucharest Flight Information Centre upgrade	Planned for 2012
Establishment of the National Aeronautical Coordination Centre for SAR	Completed
ISO 9001:2000 re-certification for all activities in all units **ATM System**	Completed In progress, planned for 2015+
DATALINK CPDLC	Planned for end 2015
ADS-B System	Pilot project under development
VCSS replacement	Planned for end 2013
Mode S radar installation	Operational by 2012
R-NAV systems improvement	Planned for end 2012

Table 3: National Projects having relationship with the FAB

In the following Table, a list of ESSIP objectives with a direct relationship to any of the DANUBE FAB implementation activities is presented for each of the two involved States along with their current status of implementation or progress. This allows to identify the level of advancement of both ANSPs in several areas and to compare them in order to identify potential areas for cooperation or harmonization. The abbreviations used for the statuses are:

- PC: Partially completed
- C: Completed (no implementation date is shown)
- P: Planned
- NP: No Plan (no implementation date is shown)
- L: Late
- NA: Not Applicable (no implementation date is shown)

			ROMANIA		BULGARIA	
	Objective ID	**Descriptive title**	**Status**	**Planned Implementation Date (mm/yy)**	**Status**	**Planned Implementation Date (mm/yy)**
Airspace Organisation and Management	AOM13.1	Harmonize Operational Air Traffic (OAT) and General Air Traffic (GAT) handling	PC (NP for Military)	12/2015	P	12/2015
	AOM19	Implement Advanced Airspace Management	PC	12/2015	PC	12/2015
	AOM20	Implement ATS Route Network (ARN) - Version 7	P	10/2013	P	10/2013
ATC & data Process Systems	ATC12	Implement automated support for conflict detection and conformance monitoring	P	01/2015	C	-
	ATC15	Implement, in En-Route operations, information exchange mechanisms, tools and procedures in support of Basic AMAN operations	P	01/2017	NP	-
	ATC16	Implement ACAS II compliant with TCAS II change 7.1	P (NP for Military)	01/2015	P	01/2015
FCM - Flow and Capacity Management	FCM01	Implement enhanced tactical flow management services	L (NP for Military)	12/2012	C	-
	FCM03	Implement collaborative flight planning	L (NA for Military)	12/2012	C	-
Aeronautical Information Management	INF04	Implement integrated briefing	L (NP for Military)	12/2012	L	12/2012
Interoperability	ITY-FMTP	Apply a common flight message transfer protocol (FMTP)	P (NP for Military)	12/2014	C (N/A for Military)	-
	ITY-AGDL	Initial ATC air-ground data link services above FL-285	P (NP for Military)	02/2015	P (NA for Military)	02/2015

			ROMANIA		BULGARIA	
	Objective ID	**Descriptive title**	**Status**	**Planned Implementation Date (mm/yy)**	**Status**	**Planned Implementation Date (mm/yy)**
	ITY-AGVCS	Air-Ground voice channel spacing above FL-195	PC (PC for Military, rest is C)	12/2015	PC (P for Military, rest is C)	12/2012
	ITY-COTR	Implementation of ground-ground automated co-ordination processes	PC	02/2015	PC	12/2014
	ITY-ADQ	Ensure quality of aeronautical data and aeronautical information	P	07/2017	P	07/2017
Human resources Management and Human Factors	HUM01.1	Ensure timely availability of ATCOs	PC (NP for Military, rest is C)	12/2012	PC (NA for Military)	12/2012
	HUM02.1	Integrate Human Factors into ATM Operations	PC (NP for Military)	12/2012	PC (NA for Military)	12/2012
	HUM03.1	Integrate Human Factors into the lifecycle of ATM systems	PC (NP for Military)	12/2012	C	-
Communications	COM06	Migrate to ATS-Qsig digital signalling for ground telephone applications	NA	-	NA	-
	COM09	Migrate ground international or regional X.25 data networks or services to the Internet Protocol	L (NP for Military)	12/2012	L (NA for Military)	12/2012
	COM10	Migrate from AFTN to AMHS	PC	12/2014	P (NA for Military)	12/2014
	COM11	Implementation of Voice over Internet Protocol (VoIP) in ATM	P (NP for Military)	12/2020	NP	
Navigation	NAV03	Implementation of P-RNAV	C	-	L (NA for Military)	12/2016
	NAV10	Implement APV procedures	P	12/2015	P	12/2016
Surveillance	SUR02	Implement Mode S elementary surveillance	L	04/2012	NA	-
	SUR04	Implement Mode S enhanced surveillance	L	04/2012	NA	-
	SUR05	Improve ground-based surveillance using ADS-B in Non Radar Airspace (NRA)	NA	-	NA	-

Table 4: ESSIP objectives status for each ANSP [18][19]

More details on each objective implementations and status can be found in the referenced documents.

From a high level analysis it can be noticed that in the area of Airspace Organization and Management there is great alignment of the current status of implementation of the objectives, with the implementation of Advanced Airspace Management (AOM19) through the LARA system, being the major introduction planned by both ANSPs in the next period.

Regarding ATC & data Process Systems, the implementation of automated support for conflict detection and conformance monitoring (ATC12) is currently planned in Romania, while in Bulgaria MTCD/MONA functions have been implemented within the CNATCC project. The tools and procedures in support of Basic AMAN operations (ATC15) are planned to be implemented in the future version of the Romanian ATM System while for BULATSA there are currently no plans to implement basic AMAN operations and any future plan will depend on implementation in neighbouring states. Other objectives in this area are ether partially completed or there are plans which are aligned.

Regarding Traffic Flow and Capacity Management, Bulgaria seems more advanced in the fulfilment of ESSIP objectives, due to the functionalities offered by STACAS system. In Romania the automatic receiving and processing of ICAO FPL/RPL IFPS data is already in use, while actions are in progress for its full implementation in the framework of a contract with the supporting Company. Some SLoAs are under further consideration and review by ROMATSA.

Regarding Aeronautical Information Management, the planned implementation date for integrated briefing (INF04) for ROMATSA may be postponed in accordance with the progress achieved by EAD related to the implementation of integrated briefing (12/2012), while for MIL stakeholders the objective is under review and further consideration. For BULATSA the MET self-briefing system is implemented at Sofia/Plovdiv/Burgas and Varna airports and the terminal integration of ARO/MET briefing facilities will be completed in 2012.

Regarding Interoperability, there is great alignment of the current status of implementation of the objectives. Air-Ground data link services (ITY-AGDL) are planned according to parallel plans. The implementation of 8.33 KHz channel spacing (ITY-AGVCS) has been completed by both Countries for civil applications. The application of a common FMTP (ITY-FMTP) has been achieved by BULATSA through the current ATM system (SATCAS), capable of supporting the OLDI data exchange via TCP/IP. The Romanian national data communication network has got this capability and the ATM system related upgrade was contracted. The implementation of ground-ground automated co-ordination processes (ITY-COTR) are partially completed by both Countries for civil aviation, while full implementation is planned both by ROMATSA and BULATSA. The ITY-ADQ objective to ensure quality of aeronautical data and aeronautical information is planned according to synchronized due dates.

Regarding Human Resources Management and Human Factors, both States have partially completed all the objectives according to synchronized plans (HUM01.1 and HUM02.1). Just for the Integration of Human Factors into the lifecycle of ATM systems (HUM03.1) BULATSA has completed the objective during the during the SATCAS implementation, while for ROMATSA there are plans in progress to ensure usability of ATM working positions.

Regarding Communication capabilities, both Countries are out of the applicability area for migration to ATS-Qsig (COM06). The migration of data networks to IP (COM09) is planned by both Countries but currently late. For ROMATSA the data network is already IP capable both for internal and international services and migration was already performed with most of the neighbouring countries. For BULATSA the current FDPS has the capabilities to support flight data exchange with IPv4, while the implementation of IPv6 is planned for 2012. The migration to AMHS (COM10) has been started by both and is planned to be achieved in parallel. The implementation of VoIP (COM11) is planned to start in 2012 for ROMATSA while there are no plans for BULATSA to upgrade the existing VCS system due to system lifecycle expiry and the purchase and installation of new VCS equipment able to support VoIP in ATM will be planned.

Regarding Navigation Capabilities, the implementation of P-RNAV (NAV03) has been completed for ROMATSA while BULATSA plans PBN implementation for Sofia, Varna and Burgas TMAs by the end of 2015 and by the end of 2016 for Plovdiv and Gorna Oriyahovitsa CTRs. The same schedule applies for the implementation of APV procedures (NAV10) for BULATSA while for ROMATSA actions are planned in coordination with all stakeholders.

Regarding Surveillance capabilities, for the implementation of Mode S (SUR02 and SUR 04) ROMATSA has developed a deployment plan, contracts being established for the implementation until 2012. Romania has joined the applicability area in 2011, thus the objective is "Late". This objective is considered not applicable for Bulgaria because the State is outside of the applicability area. The procurement of Enhanced Mode-S sensors is planned for 2013 but there are no plans to start with Mode-S operations. Both States are outside the applicability area for the improvement of ground-based surveillance using ADS-B in Non Radar Airspace (SUR05).

3.4 Cost effectiveness analysis

A set of financial and economic indicators for both ANSPs are introduced in this section in order to complete the picture of the current situation and to compare the performances of the two ANSPs in terms of Financial and Economic Cost-Effectiveness. This assessment is functional to the identification of absolute and comparative advantages between the ANSPs and within the whole DANUBE FAB, based on specific indicators referred to the current situation with no FAB in place. The source used as reference for such analysis is the ATM Cost-Effectiveness (ACE) 2009 Benchmarking Report prepared by EUROCONTROL [14].

The analysis is based on the en-route Cost-Effectiveness indicators, since the DANUBE FAB implementation will mainly impact the en-route part of ATM/CNS provision. However also gate-to-gate indicators are presented, in order to maintain the link with the source [14], which focuses on the gate-to-gate comparison of Cost-Effectiveness and in order to establish a framework support for the analysis.

The following diagram describes the main logical blocks interfering in the calculation of indicators and their relationships. The term flight-hour is intended as IFR flight hour for the en-route part of the analysis, while it is intended as composite flight hour (i.e. including Airport movements) within the Gate-to-gate analysis. Similarly the cost figures have been broken down into the en-route and gate-to-gate components, allowing the distinction in the analysis.

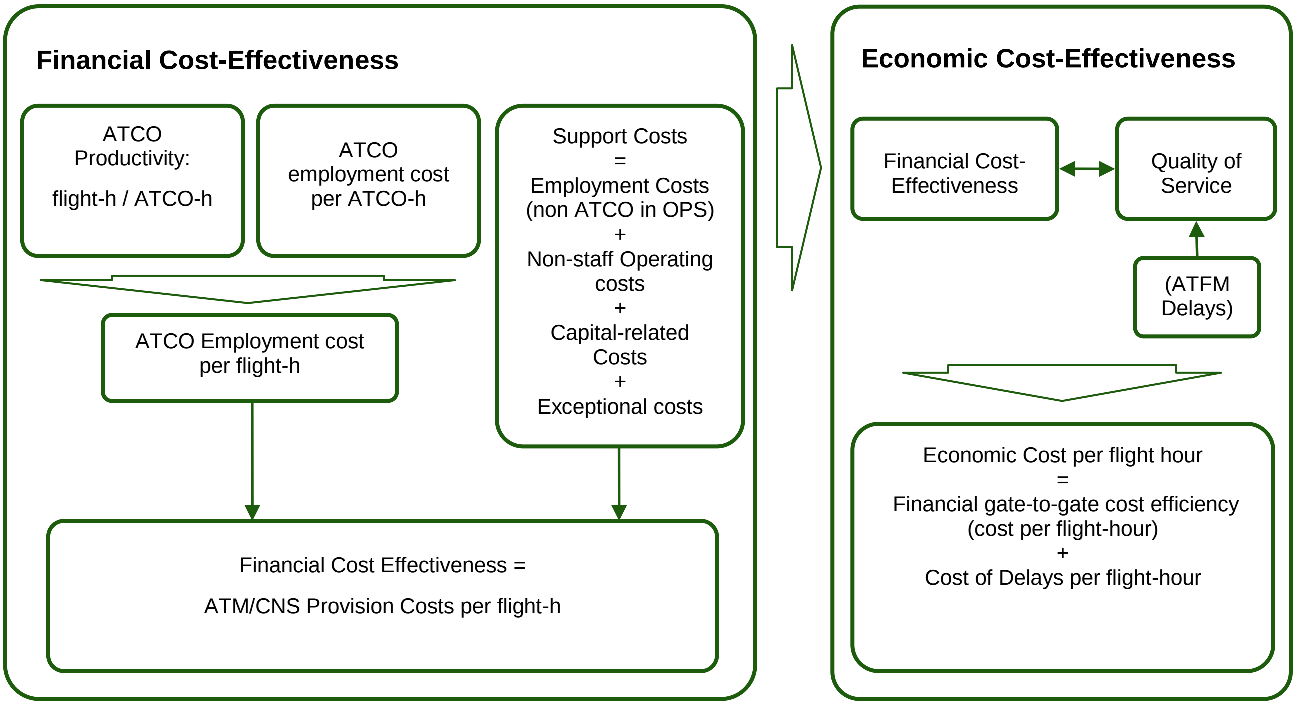

Figure 8 Layout of the Cost-Effectiveness structure extracted from ACE 2009 Report

The cost-effectiveness assessment structure provides with two main concepts that can be used to identify absolute and comparative advantages for the ANSPs being studied: the financial cost-effectiveness and the economic cost-effectiveness. The latter takes into account the trade-off between the former and the quality of service, for which the ATFM delay is considered the main indicator. The cost caused by ATFM delay is usually added to the ATM/CNS costs of service provision to represent the economic costs of service provision. However both ROMATSA and BULATSA did not register any capacity shortage in 2009, hence the quality of service can be considered equivalent and correspondent with its maximum achievable level for both. Moreover the financial and the economic cost-effectiveness will coincide. Hence the financial cost-effectiveness is sufficient in this case to quantify the performances based on the costs related to each ANSP and see how they have been evolving and how they are distributed in the current situation.

Field	Indicator / figure	BULGARIA	ROMANIA
Airspace size	1) Area (km^2)	145120	255000
Traffic outputs	2) Service Units (M)	1,8	3,4
	3) Complexity score	2,4	3,3
	4) Seasonal variation: peak/ average week	144%	135%
ANSP Operations	5) ATCOs in OPS	216	513
	6) Total IFR flight-hours controlled by ANSP	161000	264000
	7) ATCO-hours on duty per ATCO per year	1305	1384
ANSP Operations (en-route)	8) En-route ATFM delays (min)	0	0
	9) ACC ATCOs in OPS	99	292
	10) IFR flight-hours controlled by ANSP at ACC level	149519	244649
	11) Sector hours	36996	75807
	12) En-route ATCO hour productivity (flight-h / ATCO-h) [10/(9*7)]	1,16	0,61
	13) Staffing per sector (ATCO-hours / sector-hour) [(9*7)/11]	3,49	5,33
En-route ATM/CNS provision costs and Financial Cost-Effectiveness.	14) En-route ATM/CNS provision total costs (M€)	66,8	126,6
	• 14a) Staff costs (M€)	37,1	72,9
	• 14b) Non-staff Operating costs (M€)	7,5	29,1
	• 14c) Depreciation costs (M€)	11,7	8,5
	• 14d) Cost of Capital (M€)	10,5	9,4
	• 14e) Exceptional items costs (M€)	0	6,6
	15) En-route ATM/CNS provision costs per en-route IFR flight-hour controlled by ACC (€/ACC en-route IFR flight-h) [14/10]	447	517
	• 15a) Staff costs per en-route IFR flight-hour controlled by ACC (€/ACC en-route IFR flight-h)	248	298
	• 15b) Non-staff Operating costs per en-route IFR flight-hour controlled by ACC (€/ACC en-route IFR flight-h)	50	119
	• 15c) Depreciation costs per en-route IFR flight-hour controlled by ACC (€/ACC en-route IFR flight-h)	78	35
	• 15d) Cost of Capital per en-route IFR flight-hour controlled by ANSP (€/ACC en-route IFR flight-h)	70	38
	• 15e) Exceptional items costs per en-route IFR flight-hour controlled by ACC (€/ACC en-route IFR flight-h)	0	27
	16) En-route ATM/CNS provision costs per IFR flight hour controlled by ANSP (€/total en-route flight-h) [14/6]	414	480
Gate-to-Gate ATM/CNS provision costs and Financial Cost-Effectiveness ***Performance Ratios represent the relationship between the value for an ANSP of an indicator and the value of that indicator for the European system as a whole. Performance ratios are defined such that a**	17) Gate-to-gate ATM/CNS provision costs per composite flight hour (€/composite flight-h)	414	480
	18) Gate-to-gate ATM/CNS provision costs per composite flight hour Performance Ratio* (Financial Cost-Effectiveness PR)	1,05	0,91
	ATCO employment: 19) ATCO employment cost per composite flight-h (€/composite flight-h)	78	120
	ATCO employment: 20) ATCO employment cost per composite flight-h Performance Ratio*	1,74	1,13
	ATCO employment: • 20a) ATCO hour productivity (composite flight-h / ATCO-h)	0,65	0,43
	ATCO employment: • 20b) ATCO hour productivity Performance Ratio*	0,90	0,59

Field			Indicator / figure	BULGARIA	ROMANIA
value greater than one implies a performance <u>better</u> than the European average, in terms of the positive contribution it makes to cost effectiveness. **** Real employment costs are deduced from the PPP-adjusted employment costs shown in [14] as:** **Real cost (€) = Adj.Cost(€) x (PPP/Exchange rate (1€=)).** **Values for PPP and Exchange rate are extracted from [14]**		•	20c) ATCO Employment cost per ATCO hour (€/ATCO-h)	51	52
			20d) Employment cost per ATCO hour Performance Ratio*	1,94	1,91
	Support		21). Support costs per composite flight-h (€/composite flight-h)	336	360
			22) Support costs per composite flight-h Performance Ratio*	0,89	0,83
		•	22a) Non-ATCO in OPS employment cost per composite flight-h (€/composite flight-h)	159**	156**
		•	22b) Non-staff operating costs per composite flight-h (€/composite flight-h)	47	108
		•	22c) Cost of exceptional items per composite flight hour (€/composite flight-h)	0	27
		•	22d) Cost of capital per composite flight-hour (€/composite flight-h)	59	35
		•	22e) Depreciation Costs per composite flight-hour (€/composite flight-h)	71	32
		•	22f) Gate-to-gate total ATM/CNS assets (M€)	115	114
			22g) Gate-to-gate ANS total capex (M€)	3	12

Table 5: Financial cost-effectiveness Indicators [14]

From the indicators presented in Table above it is possible to appreciate the higher en-route ATCO productivity for BULATSA with respect to ROMATSA. This is due to a mix of lower staffing per sector expressed in ATCO-hours per sector hour (line 13) and higher sector productivity expressed in flight-hours per ATCO-hour (line 12).

Regarding the en-route financial cost-effectiveness, ATM/CNS provision costs per en-route IFR flight-hour controlled by ACC (line 15) is 16% higher for ROMATSA than for BULATSA. This is mainly due to the higher non-staff Operating costs (line 15b) whose value per en-route IFR flight-hour controlled is 140% higher in ROMATSA. This takes into account expenses like rentals, energy, telecom, insurance, outsourced maintenance, etc.

The impact of staff costs is lower and when expressed by staff cost per en-route IFR flight hour controlled (line 15a) this is only 20% higher in Romania than in Bulgaria. When compared to the equivalent indicator for the gate-to-gate situation, the performances for ROMATSA worsen, since employment cost per ATCO hour is 54% higher in Romania.

Although all the above indicators stem from 2009 data published in [14], which is the latest published reference at the time of writing this report, it is worth considering the variation in the number of ATCOs in OPS in 2010, based on 2010 data contained in the Information for Economic Disclosure [6]. This latter reference contains the information submitted by the ANSPs to EUROCONTROL and it is used as input for ACE, therefore, the following variations in number of ATCOs in OPS can be consistently provided as follows:

- Number of ATCOs in OPS dropped by 10% for BULATSA (from 216 in 2009 to 195 in 2010). More specifically, ACC ATCOs in OPS (en-route) decreased by 7% (from 99 in 2009 to 92 in 2010).
- Number of ATCOs in OPS experienced a more notable decrease of 14% for ROMATSA (from 513 in 2009 to 440 in 2010). This drop is mainly due to the decrease in number of ACC ATCOs in OPS (en-route), which experienced a notable reduction of 25% (from 292 in 2009 to 220 in 2010).

The considerable reduction in the number of en-route ATCOs experienced by ROMATSA coupled with the continuous traffic increase, implies an improvement in 2010 ATCO productivity. This is made possible by the centralisation of the all operational units in Bucharest ACC. Regarding the capital related costs, they affect more negatively BUALTSA performances, since Depreciation and Capital costs per en-route IFR flight-hour are almost double for Bulgaria than for Romania (lines 15c and 15d).

Also the Exceptional items costs negatively affect ROMATSA performances when compared to BULATSA ones (line 15e).

3.4.1 Evolution of gate-to-gate cost-effectiveness indicators

In order to obtain a more meaningful basis for the analysis, the 2009 information presented in the table above can be combined with extra data, setting out the changes that some indicators related to the gate-to-gate Financial cost-effectiveness have experienced during the period 2005-2009. The table below shows this information, extracted from the same source as the 2009 indicators above [14]. Since this information is available only at an aggregated gate-to-gate level it is not directly relevant to the FAB framework, but is nevertheless indicative of the overall performances of the ANSPs.

	KPI changed over 2005-2009 period	BULGARIA (VARIATION)	Weight for BUL	ROMANIA (VARIATION)	Weight for ROM
Gate-to-gate ATM/CNS provision costs per composite flight hour variation		**-36%**	**N/A**	**-5%**	**N/A**
ATCO employment	ATCO employment cost per composite flight-h variation	-28%	18%	+7%	25%
	• ATCO hour productivity variation	+46%		+23%	
	• Employment cost per ATCO hour variation	+5%		+31%	
Support		-38%	82%	-9%	75%
	• Total Support costs variation	-22%		-3%	
	• Traffic variation	+25%		+6%	

Table 6: Variation of the KPIs affecting financial cost-effectiveness (2005-2009) [14]

It can be noticed that financial cost-effectiveness improved much more considerably during the 2005-2009 period for BULATSA than for ROMATSA. The 22% decrease of total support costs together with the 25% traffic increase involved a 38% of reduction in the support costs per composite flight-hour over the period for Bulgaria. This effect is combined with a great ATCO productivity increase of 46% and a low increase of 5% of the ATCO employment costs. These two elements contributed to the increase of the financial cost-effectiveness with a 28% reduction of the ATCO employment costs per composite flight hour.

On the other hand, for ROMATSA, the support costs only decreased by 3% while the traffic had a modest increase of 6% compared to the Bulgarian 25%. These effects resulted in a 9% reduction of support costs per composite flight hour, that are combined to a 7% increase of ATCO employment costs per composite flight hour. This in turn is caused by an increase of 31% in ATCO employment costs and of just 23% in ATCO productivity.

In order to identify the absolute and comparative advantages of the ANSPs being studied, it is necessary to account for the diverse factors that can influence performances. According to [14], these can be separated in two categories: exogenous and endogenous factors. The former are those outside the control of an ANSP, while the latter are those entirely under the ANSP's control. Fair benchmarking of ANSP performance needs to recognise the impact of exogenous factors. Effective target-setting will need to account for exogenous factors to the maximum extent possible, while encouraging the optimisation of endogenous factors through the recognition and movement towards best practices.

3.4.2 The impact of exogenous factors onto performances

Exogenous factors can be sub-classified in Legal and socio-economic conditions, operational conditions and institutional and governance arrangements. For the context of this study, and taking into account that both states are within the European Union, the general exogenous factors considered to impact the performances are:

3.4.2.1 Cost of living

The cost of living factor has an impact in determining some differences in costs (e.g. staff) accounted by each ANSP, considering that cost of living is overall higher in Romania than in Bulgaria as indicated by the difference in Purchasing Power Parity (PPP). However the use of PPP is controversial because of the difficulties of finding comparable baskets of goods to compare purchasing power across countries. Moreover within the same Country there are notable differences and between regions (e.g. between the capital and other cities) which cannot be catch by a single indicator. Therefore the cost of living factor has not been considered in this analysis as a justifying factor for explaining differences in cost-effectiveness.

3.4.2.2 Traffic complexity

Traffic complexity is a metric that considers the density and structural complexity of traffic. The relationship between "traffic complexity" and cost-effectiveness is not straightforward. The effects of traffic complexity on ATM performance can work in either of two ways, which go in opposite directions:

- Higher density is expected to contribute to a better utilisation of resources and to more effective exploitation of economies of scale (up to the point when resources become fully utilised);
- Higher structural complexity entails higher ATCO workload and more sophisticated ATM systems and tools for the same volume of traffic.

As shown in Table 5, values of complexity score are 2,4 for Bulgaria and 3,3 for Romania (line 3).

3.4.2.3 Seasonal traffic variability and Airspace size

When traffic is highly variable, resources may be underutilised, or made available when there is little demand for them. This results in allocative inefficiency. Variability in traffic demand is therefore likely to have an impact on productivity, cost-effectiveness, quality of service and predictability of operations. Variability can exist both in the temporal dimension (seasonal, within-week or hourly) and in the space dimension (variability in tracks). Traffic has great seasonal variation for both ANSPs, being 144% variability for BULATSA and 135% for ROMATSA. These are among the highest seasonal variability rates in Europe.

Airspace size is another exogenous factor affecting performances: for a higher Airspace more resources are needed to control a higher number of flights, but on the other hand economies of scale are possible. Romanian airspace is 76% bigger than Bulgarian.

Part of the differences in productivity can be due to the combination of these factors. Inefficiencies in sectorization due to a higher airspace and with high traffic variability, may imply in fact a higher staffing per sector (line 13) in ROMATSA than in BULATSA.

3.4.3 The impact of endogenous factors onto performances

Endogenous factors express the way that an ANSP manages its business to optimise performance and are influenced by exogenous factors. As stated in [14], "Best practice" in any given area will depend on the exogenous circumstances. ANSPs can take action to fully exploit the benefit of their environment or to minimise the impact of relative disadvantages. Therefore, the impact of an exogenous factor should not be analysed in isolation from an analysis of the degree to which this impact has been minimised or maximised through appropriate internal measures (endogenous factors).

Three groups of endogenous factors are identified: organisational factors, managerial and financial aspects, and operational and technical setup. Among these groups, there is a wide set of factors from which the following have been selected to be especially taken into account:

3.4.3.1 Organizational factors

The Degree of centralisation is one of the main aspects to be taken into account when analyzing endogenous factors affecting financial cost-effectiveness. The en-route ATS for the whole Romanian Airspace included in the Bucharest FIR are planned to be provided only from Bucharest ACC in 2012. This organisation is being achieved thanks to an effective program for enhancement of cost-effectiveness undertaken by ROMATSA since 2008, which has gradually led to the centralization of physical locations from 3 (Constanta, Arad and Bucharest) to 1 (Bucharest).

If this measure allowed to achieve a high degree of centralization on one hand, on the other one implied a significant increase in employment costs per ATCO-hour observed in 2008 (+18%) due to the implementation of a new collective agreement and the re-location of staff from Arad to Bucharest operational units. On the other hand the number of ATCOs in OPS is planned to reduce by some -3 % p.a. as a result of this consolidation of ACC operational units.

Regarding the Bulgarian Airspace, the Sofia ACC is the only entity in charge of ATS provision for the homonymous FIR. No ATCO overtimes have been registered in the period 2005-2009 for both ANSPs, hence staffing and rostering are considered well designed to respond to actual needs.

3.4.3.2 Management factors: recruitment and training

The existing recruitment, selection and training systems in the ANSPs exhibit a number of differences (deriving from differences in operational needs, educational background and other influences such as culture and language), but there are also a number of commonalities. For both ANSPs, ATCO training consists of:

- Initial Training (IT),
- Unit Training (UT),
- Continuation Training (CT) and
- Development Training (DT).

In the initial training phase, basics of ATC theory and technical subjects are considered, and training is provided in simulators. The initial training phase is typically provided at a training academy. In the unit training phase, development is continued with the objective of obtaining an air traffic controller license. Unit training is mostly performed 'on-the-job' at the operational units. After obtaining the controller license, continuation training is provided to augment existing knowledge and skills, and development training is aimed at developing additional knowledge and skills.

There are significant similarities in the main content of initial training, but differences between additional subjects such as English language, procedural control and radiotelephony may be found.

The organisation of unit training differs much across ANSPs and heavily depends on the operational situation. The structure and length of the unit training programs depends on the unit and/or the number of positions, and therefore unit training is less prone to be harmonised than initial training.

Both ANSPs deliver continuation training internally. The content, length and frequencies vary per year and depend on operational needs. With respect to development training, courses are provided by ANSPs for licensed functions: ATCO, on-the-job training instructor (OJT-I), assessor, examiner, and supervisor. Initial training instructors are typically operational or retired ATCOs. At the unit training stage, OJT-Is are operational ATCOs or recently retired ATCOs. Further than the content, the tools used include radar simulators, tower simulators and computer based training (CBT) programmes.

3.4.3.3 Financial and accounting aspects

BULATSA assets under construction have been consistently below 10% of total fixed assets since in the period 2006-2009 and the average remaining accounting life of the fixed assets has been continuously declining since 2005, although remaining high at 8 years. This reflects the significant investments made prior to 2004 and between 2005 and 2009 (€44M). The significant capital expenditure in 2008 included the upgrade of the SATCAS system (FDP, RDP and HMI) in Sofia ACC.

For ROMATSA, in the period 2005-2009, assets under construction have been consistently below 10% of the net book value of total fixed assets and the average remaining accounting life increased to reach some 11 years in 2009.

In 2009 for ROMATSA some €698 of fixed assets were required per composite flight-hour (a productivity of 1,4 composite flight-hour per €1000 of fixed assets). A level significantly higher than BULATSA (1,0). Modernization of ATM system, within the Technical Operational Strategy ROMATSA 2012+, was approved in 2009 and represented a CAPEX of €17,4M occurred between 2008 and 2011 which included the upgrade of the FDP system in 2009. Further the ROMATSA ATM system 2015+ program between 2011 and 2014 foresee a CAPEX of around €80M, 85% of which are imputable to the provision of en-route ANS and hence falling within the context of FAB.

The differences between investment programs undertaken in past years by the two ANSPs justify the higher depreciation and capital costs per en-route IFR flight-hour registered by Bulgaria (lines 15c and 15d).

3.4.4 Identification of Absolute and comparative advantages

From the analysis presented so far, the following indications for exploiting the absolute and comparative advantages can be derived:

- The geographical location of the DANUBE FAB, aligned with the main observed traffic flows, indicates its high fitness to the high level objectives for the creation of Functional Airspace Blocks. Moreover there is an overall alignment between ROMATSA and BULATSA regarding CNS capabilities and implementation of ESSIP objectives, indicating that harmonization of operations according to the DANUBE FAB distributed architecture can occur without requiring major investments by ANSPs involved.
- A number of common technical capabilities implementation programs exist and are aligned in their schedules. A potential advantage for both ANSPs in this respect would be represented by a common procurement of the related systems aimed at reducing capital-related support costs, enabled by previous detailed analysis and business plan to be developed on a case-by-case basis. This requires a previous alignment of the national business plans, which are influenced by different historical activities and hence it is considered a mid-term area for improvement. This is however considered an area of major importance due to the considerable impact on the following KPAs:
    - Technical interoperability: the harmonization of technological capabilities and interfaces between the two ACCs operating within the DANUBE FAB will allow a more advanced implementation of the distributed architecture concept, thus being an enabler for increasing ATCO productivity by decreasing their workload;
    - Cost-effectiveness: the common procurement of ATM systems could provide significant economies of scale throughout the different phases, from system design through deployment and maintenance. This requires a previous alignment of the national business plans, which are influenced by different historical activities and hence it is considered a mid-term area for improvement.
- The generally higher cost of living registered in Romania, coupled with the faster traffic growth experienced in Bulgaria in the last years than in Romania, could partially justify the differences in staff cost per en-route IFR flight hour controlled. It is considered that the joint elaboration of a DANUBE FAB Performance Plan starting from the second reference period, would represent an opportunity for partners to further exchange best practices impacting a set of performance metrics as the ones reported in the ACE, for the achievement of the EU-wide performance targets.
- In the case the abovementioned impact of cost of living on employment costs is confirmed, this could imply an impact in both ATCO and non-ATCO staff employment costs. Nevertheless the evolution of these costs could be taken into account, together with the overall planned levels of productivity, by a joint DANUBE FAB performance planning process starting from the second reference period.
- The difference in non-staff Operating costs (e.g. rentals, energy, telecom, insurance, etc.) can partially be due to the differences in costs of living and partially to different management programs undertaken in the past at National levels. It is however considered that the program for enhancement of cost-effectiveness undertaken by ROMATSA since 2008, which has gradually led to a reduction of almost 25% in the total number of staff and to the centralization of physical locations from three (Constanta, Arad and Bucharest) to one (Bucharest), provides an effective measure to lower non-staff operating costs and will lead to harmonization in the performances between the two partners. This is to be considered as a continuous gradual process rather than as a one-off action, in which both ANSPs are going to participate for the improvement of their individual performance in a FAB environment, applying the best practices derived from their own experience.
- The difference in traffic complexity (+38% in Romanian Airspace) can partially explain the differences in en-route ATCO productivities between BULATSA and ROMATSA. A higher ATCO

workload per unit of traffic controlled may imply lower sector productivity expressed in flight-hours per ATCO-hour. To exploit the differences it is therefore considered valuable to extend airspace design and management to a common function at DANUBE FAB level, in order to smooth the gap in performances by improving the sector opening schemes and simplifying the overall traffic complexity, thanks to the elimination of boundary constraints.

- Since the DANUBE FAB is based on the distributed architecture concept, it is considered that maintaining the two ACCs (Sofia and Bucharest) is the most efficient solution achievable in terms of degree of centralization.
- Initial cooperation has been undertaken by ROMATSA and BULATSA for the formulation of standards and methodologies for personnel training in DANUBE FAB, which identified some limited opportunities for cost reductions. In the mid-term and depending on the commonalities of technical ATM system it is foreseen that relevant benefits can be derived by the creation of a common training organization, possibly situated at a limited number of physical locations. This is considered unfeasible in the short-term mainly due to the differences in technical systems, national languages and organizational structures of the ANSPs.
- The differences in cost of capital due to different capital-related expenditures in past years reflect the national approach to the definition CNS Strategy adopted by each ANSP. The adoption of an harmonised CNS Strategy would represent an advantage for both ANSPs. The advantage is based on the possibility of rationalising the deployment of CNS-related infrastructure on the overall FAB territory instead than on the national, exploiting the coverage of CNS systems and hence avoiding duplications of capital costs.
- Support cost and ATCO productivity are coupled in such a manner that a rise of ATCO productivity is implied by specific investments in ATM/CNS systems which, in turn, means an increase in CAPEX (increase of support costs). On one hand this fact can partially explain the difference in ATCO productivity between BULATSA and ROMATSA, since the former registered higher capital-related costs in 2009. On the other hand the influence between capital investments and ATCO productivity is expected to decrease in the FAB scenario, thanks to the positive impact of the new airspace and network design on ATCO productivity.

4 Methodology

4.1 Approach to the analysis

In this section a detailed analysis is given of the relationships between joint activities performed under the DANUBE FAB common functions, their main impacts having economic repercussion (either as a cost or a benefit), the stakeholder affected and the input data used to quantitatively assess the impact.

The analysis tackles separately the economical impacts on external stakeholders (airspace users) on the one hand and internal stakeholders (ANSPs) on the other, by developing independent models and benefit mechanisms, described in sections 4.2 (airspace users model) and 4.3 (ANSP model). These models are based on the European MOdel for ATM Strategic Investment Analysis (EMOSIA). Although the two models naturally interact with each other from economical perspective due to the financing of ATS through air navigation charges, they have been maintained separate for the purposes of this analysis. This implies that costs and benefits impact either the internal or external model, ensuring in this way that double counting is avoided. However specific figures regarding the impact of internal benefits onto Airlines in terms of savings per service unit and per flight are provided in section 5.2.4 to complement the models' results expressed as Net Present Values.

The following initiatives have been considered separately as operational areas being impacted by FAB implementation activities, in line with the common functions identified in [5]:

1. Airspace design & management and common operational concept
2. Harmonized training system
3. Harmonized management systems for SQSE
4. Common CNS strategy
5. Common procurement

The initiatives are in line with the common functions identified in [5], and their impact has been individually assessed in this analysis. A thorough description of each initiative and its impact on stakeholders is provided in sections 4.2.5 and 4.2.6 for airlines and section 4.3.5 for ANSPs. The Airspace design & management and common operational concept initiative is the only one which directly affects Airspace Users in terms of enhanced flight efficiency. All others involve ANSPs only.

Figure 9 resumes the high level logical structure of the overall model.

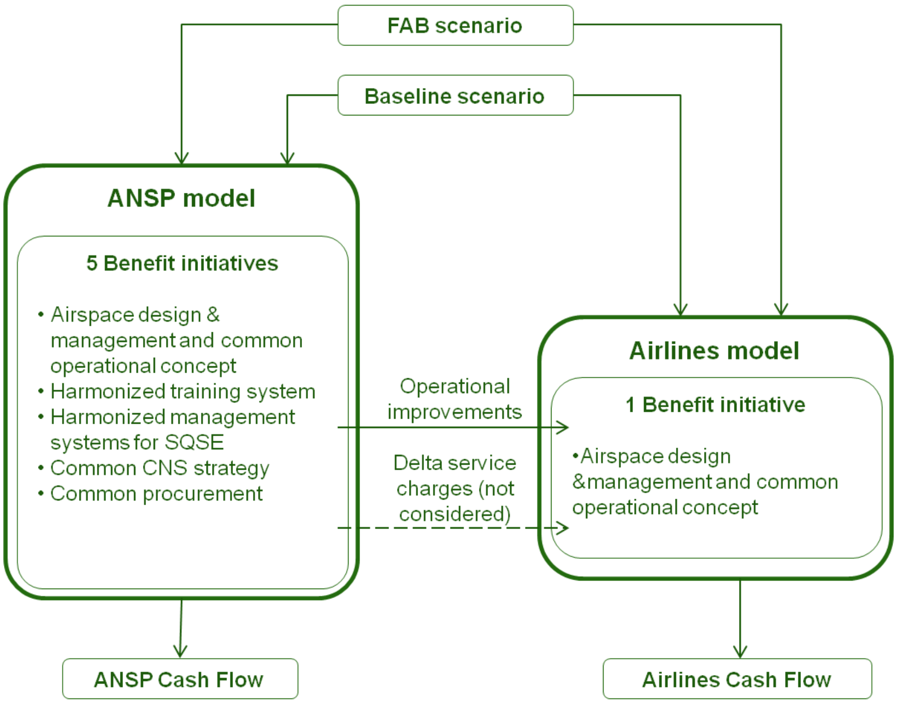

Figure 9: Relationship between stakeholder models, benefit initiatives and operational and economic interactions

For each benefit initiative a benefit mechanism has been developed which serves as basis to represent, for each stakeholder involved, the link between the activities, their operational impacts and the correspondent metrics to measure it in monetary terms. These mechanisms determine whether each area of interest will report benefits within the CBA timeframe. In detail, the benefit mechanism is built up of four columns:

- Column 1: describes each new activity introduced as a result of the FAB cooperation;
- Column 2: assesses the new activity in terms of its operational impact on airspace users or on the ANSPs;
- Column 3: describes the indicators used to quantify the operational impact in monetary terms which is then used to build up the overall cash flow;
- Column 4: include the specific Key Performance Area (KPA) impacted. The main KPAs identified for the internal benefit model are Cost effectiveness and Interoperability while in the external one are Efficiency and Environmental impact. In addition to these KPAs for which a monetary impact has been quantified, the impact on the remaining KPAs according to ICAO classification is qualitatively analyzed in the Business Case

The different arrows accompanying model diagrams indicate whether each parameter increases or decreases with respect to the baseline scenario. A colour code is used to indicate whether the parameter modification is beneficial (green) or detrimental (red) according to the specific KPA.

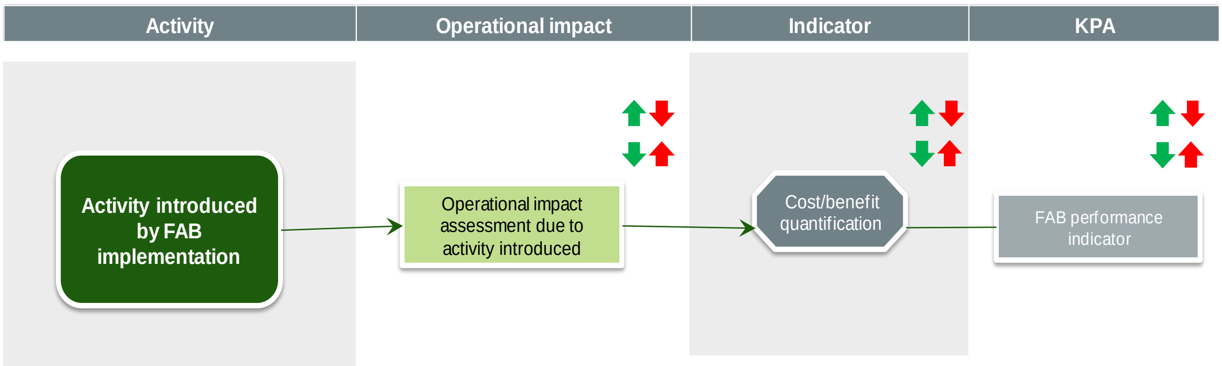

Figure 10: Benefit mechanism structure (illustrative example)

The cash flows included in the CBA are categorized according to their nature and based on the following criteria:

- **Timeframe categorization**, cash flows are classified according to the Phase of DANUBE FAB project in which they occur:
    - Pre-implementation phase: Cash flows before 2013;
    - Implementation phase: Cash flows after 2013.
- **Benefit initiative categorization,** cash flows are associated to the specific benefit initiative to which they belong;
- **Model categorization**, cash flows are associated to the specific component within the overall CBA model.

4.2 The Airline model

This section is dedicated to the explanation of the model used in the analysis to calculate the impact of FAB establishment on Airspace Users as well as a description of the input variables, their values and intermediate processing steps. The diagram in Figure 11 shows the main blocks composing the high level model and interrelationships amongst them.

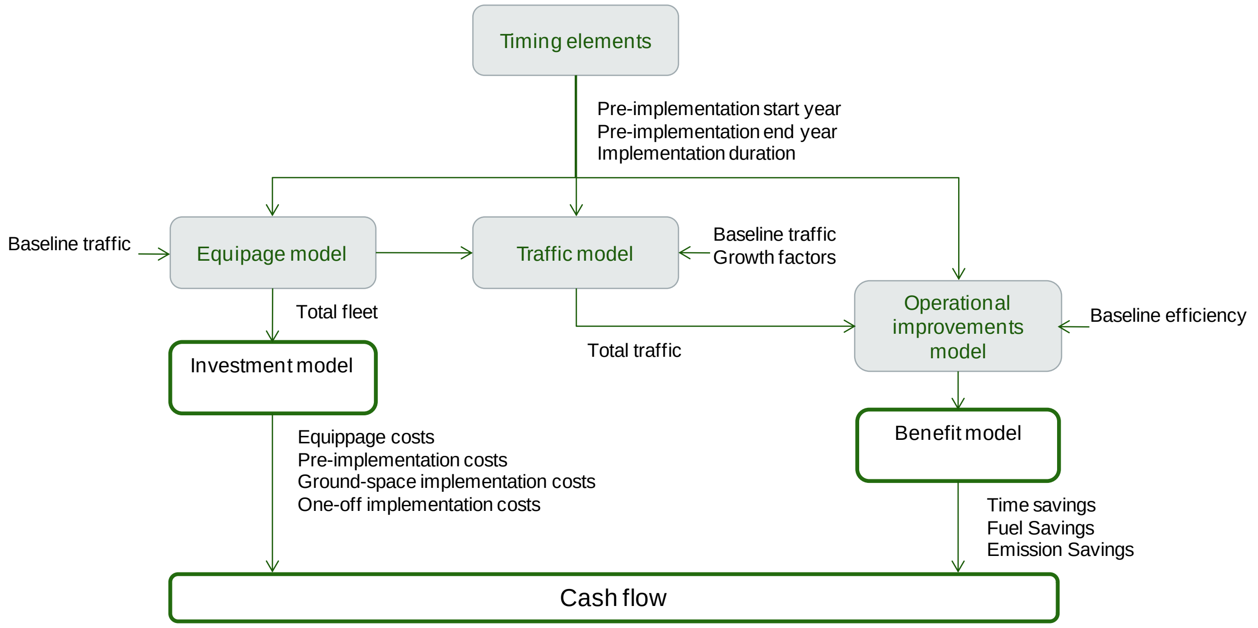

Figure 11: Airline CBA Model Overview

Table 7 below is a high-level description aimed at illustrating the way in which the generic EMOSIA Airline model [17] has been shaped and adapted to fit for purpose for the DANUBE FAB CBA. It summarizes the different variables originally included in the EMOSIA model and how they have been used within the DANUBE FAB model developed for this analysis.

Costs and benefits have to be always considered as “Delta” values with respect to the baseline scenario. Hence, variables described as not requiring investment in Table 7 are those for which changes are not expected with respect to the baseline scenario. In particular the investment model generates a null input in this analysis, since no specific investment for Airspace Users is specifically imputable to the DANUBE FAB implementation and operations.

Airline EMOSIA variable	Variable description for the DANUBE FAB CBA
Timing variables	
Pre-Implementation start year	2008
Pre-Implementation start duration	5 years (2008-2012)
Implementation Duration	18 years (2013-2030)
Operational Improvements model variables	
Baseline efficiency	Baseline efficiency indicators in terms of distance and flight time over DANUBE FAB airspace
Investment model variables (costs)	
Pre-implementation costs	No investment required to airlines in DANUBE FAB
One-off implementation costs	No investment required to airlines in DANUBE FAB
Equipage costs	No investment required to airlines in DANUBE FAB
Ground implementation costs	No investment required to airlines in DANUBE FAB
Traffic model variables	
Baseline traffic	Baseline IFR traffic from STATFOR and [4]
Growth factors	Baseline IFR growth tendencies from STATFOR and [4]
Total traffic	FAB traffic estimated figures
Benefit model variables (savings)	
Time savings	Time savings due to FAB implementation in terms of min/flight
Fuel savings	Fuel savings due to FAB implementation in terms of kg/flight
CO_2 savings	CO_2 savings due to FAB implementation in terms of kg/flight

Table 7: Airlines model variables summary and high-level description

Next sections are concerned with the detailed description, breakdown and estimation of each of these variables and explanation of elements included in the Airline model.

4.2.1 Timing elements

The timing elements are used to describe when costs and benefits are incurred according to the evolution of the DANUBE FAB project.

As previously mentioned, pre-implementation start year is 2008, time at which the first analysis were available from the Feasibility Study (Phase 1) of DANUBE FAB project, the first FAB concept was formalised and preliminary evidences of added value were produced, determining the decision to go on with the preliminary design (Phase 2).

The pre-implementation period is assumed to conclude at the end of 2012, when the DANUBE FAB is expected to be formally declared to EC and DANUBE FAB State Agreement to enter into force.

The implementation period is considered up to 2030. Even if the FAB is expected to continue beyond 2030, the temporal horizon considered in the CBA analysis has been agreed up to 2030.

4.2.2 Equipage model

The equipage model determines the number of forward fit aircraft, retrofit aircraft and the percent of the fleet that is equipped. For the aims of the DANUBE FAB CBA there is no impact of the Airspace Users' equipage on the capability to fly DANUBE FAB procedures, hence the Equipage model has no influence on the outcome of the analysis.

4.2.3 Investment model

The investment model is intended to summarize the investment costs from an Airspace Users perspective, associated with the establishment and operation of the DANUBE FAB. Generally costs may come in the form of:

- Equipage costs;
- Pre-implementation costs;
- One-off implementation costs;
- Ground implementation costs.

No specific Equipage investment for Airspace Users in ground or airborne equipment is demanded to operate in DANUBE FAB, thus limiting the impact on Airspace Users capital expenditure costs to zero. The DANUBE FAB will be capable in fact of providing equal or better levels of service, improved safety, access and efficiency to Airspace Users without requiring avionics and ground systems upgrades or training from Airspace Users.

Pre-implementation costs are considered negligible, since they would be represented by a few informative Workshops and documents to be analysed by Airspace Users, with the aim of being informed about the process of establishment of FAB.

One-off Implementation Costs are represented by one-off services, one-off operating start-up costs, and other one-off expenditure for the establishment of the DANUBE FAB. No specific one-off activity such as training or certification is considered attributable to the FAB, since the network modifications will be published by the relevant AIPs and taken into account in flight planning by Airspace Users.

In accordance with the above considerations, the output of the investment model for the Airspace User is null, thus determining an always positive cash flow.

4.2.4 Traffic Model

The traffic model serves to calculate the absolute external benefits generated by the operational improvements on the Airspace Users as a whole. It permits to translate the savings estimated for three specific days of traffic resulting from the DANUBE FAB Environmental assessment [4] to more general results on yearly basis and per airline, ensuring representativeness of the sample. Savings for each set of three days are calculated in three different scenarios: 2015, 2020 and 2030. The three characteristic days of traffic in 2010 are used as baseline for the estimation of savings in 2015, 2020 and 2030 as summarized in Table 8 below.

Date	Type of day	Total daily flights in DANUBE FAB	Weight coefficient
1/1/2010	Low traffic day	1293	A=0,0262
19/10/2010	Average day	2708	B=0,9531
2/7/2010	Peak day	3798	C=0,0207

Table 8: Traffic data used in the analysis [4]

To translate the daily figures into annual ones, specific weights coefficients have been derived according to the representativeness of the three sample days onto the entire year (column 4 in Table 8). To this aim daily traffic data for the whole year 2010 was retrieved from the STATFOR Interactive Dashboard (SID), relative to the DANUBE FAB Airspace, as described in Figure 12.

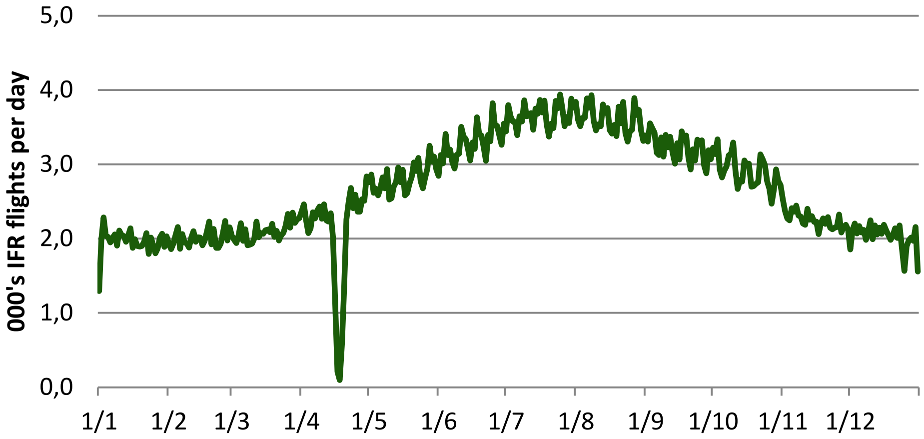

Figure 12: DANUBE FAB airspace traffic data (2010)

The weekly variation of traffic is very regular, with the exception of a sudden drop of traffic in mid-April, due to the eruption of the Eyjafjallajökull volcano, which caused the closure of a big part of the European Airspace. This outlier in the distribution has been filtered out to avoid affecting the overall average.

A balanced average is performed over the traffic time series as described in the Annex, section 8.2.1 to yield the weight coefficients reported in Table 8.

The traffic forecast has been treated as an exogenous variable, not influenced by the implementation of the DANUBE FAB and equivalent to the Baseline scenario. In line with the results reported in [4], only a fraction of the entire traffic crossing the FAB (see Annex, section 8.2.3) has been considered impacted by the operational changes progressively put in place under the correspondent FAB scenario.

The basic "Impacted Annual Traffic Forecast" (ITF) is calculated according to the daily impacted flights in the scenarios of 2015, 2020 and 2030 for the three selected representative days. Each day of traffic was multiplied by its specific weight (i.e. *A, B* or *C*) and then multiplied by 365 to obtain an annual ITF value for each of the three Scenario years.

Interpolation was then applied to yield ITF(t) as time-dependent function for the entire DANUBE FAB operations time frame, i.e., 2013 to 2030. At this point it was assumed that seasonality remains constant hence the annual representative days for 2015, 2020 and 2030 remain the same as in 2010 and their impact on the weighted average is unchanged. Refer to the Annexe, section 8.2.1 for further details on the derivation of ITF time series.

An uncertainty range is added around the impacted flights time series, in line with the distance between the high, base and low forecast traffic figures provided by STATFOR ([2], [3]) for the entire FAB traffic data, as shown in Figure 13. Specific multiplying factors Δh and Δl are calculated to obtain the high and low traffic forecast values for each year from the base value as reported in Table 9. Details on the uncertainty range derivation are summarized in the Annex, section 8.2.3.

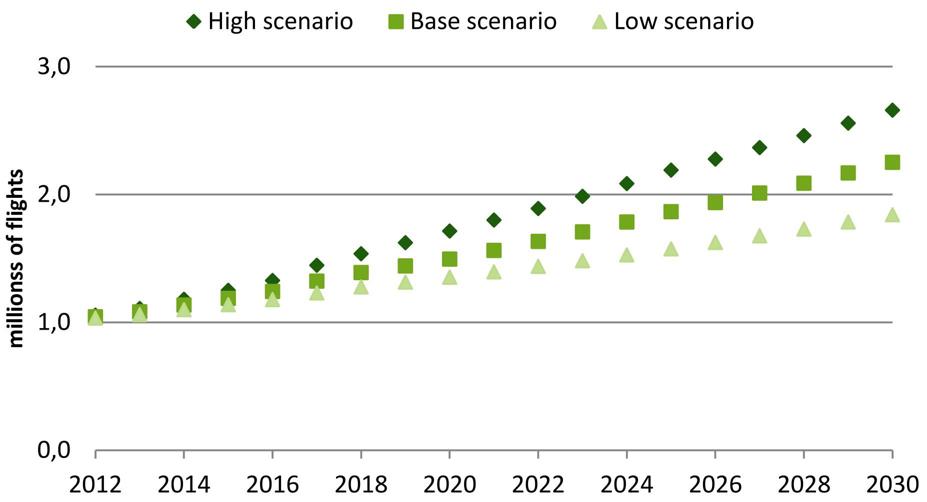

Figure 13: Annual traffic in DANUBE FAB [2] & [3]

	Multiplying factor 2015	Multiplying factor 2020	Multiplying factor 2030
High(Δh)	1,05	1,13	1,15
Base	1	1	1
Low(Δl)	0,96	0,91	0,82

Table 9: Uncertainty traffic multiplying factors for 2020 and 2030

Figure 14 depicts the evolution of Impacted Annual Traffic Forecast. The change in the ITF function slope occurring in 2020 is due to the introduction of Free Route Airspace (FRA) within the FAB [4], whereas the slope change in 2015 corresponds to a more rapid deployment rate of FAB related operational changes in the period 2012-2015. The difference in slope between the low, base and high ITF (i.e. respectively ITF_l, ITF_b and ITF_h) represents the uncertainty around the base ITF, previously calculated from STATFOR data.

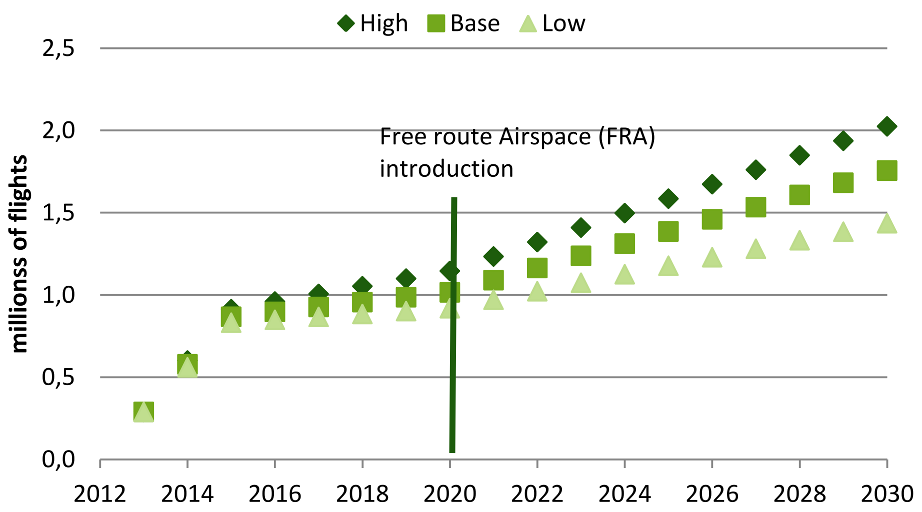

Figure 14: Impacted Annual Traffic Forecast (ITF)

The equations representing the traffic evolution in Figure 14 are collected and further manipulated in the Annexe, section 8.2.4 to be able to input them in EMOSIA. The ratio of Impacted-to-Total flights analysed in the Annexe, section 8.2.3 shows an increasing ratio of impacted flights for the periods 2012-2015 and 2020-2030.

4.2.5 Operational Changes Model

The Operational Changes model reflects the phased introduction of airspace and route network modifications according to time and leading to an enhancement of flight efficiency from Airspace Users' perspective. The diagram in Figure 15 below represents the benefit mechanism leading from the specific set of activities, related with the optimized airspace and network design enabled by a common Operational Concept at FAB level, to a set of indicators measuring the positive impact experienced by Airspace Users according to the different KPAs.

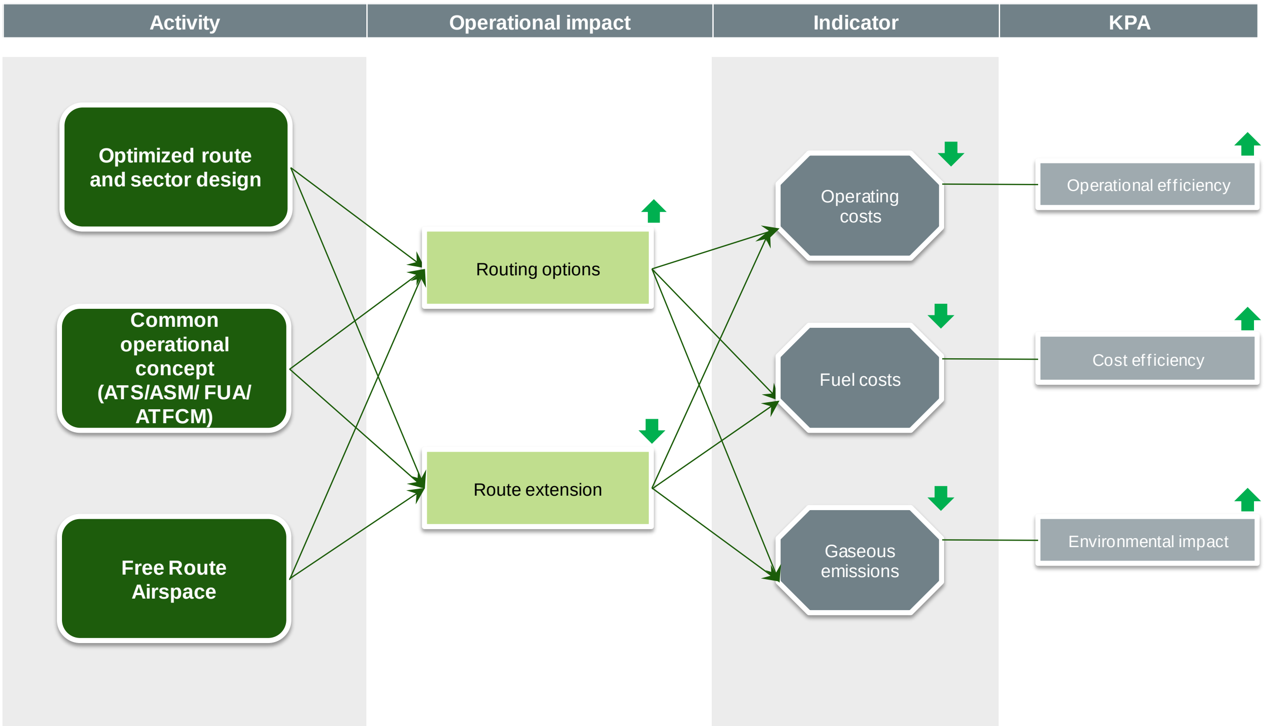

Figure 15: "Operational Changes" - benefit mechanism for Airspace Users

The assessment of the operational changes impact is provided in the Environmental Assessment [4] for 3 characteristics days in three scenarios along the DANUBE FAB time frame: 2015, 2020 and 2030 and expressed in terms of:

- Daily time savings/impacted flights [min/flight].
- Fuel savings/impacted flights [Kg/flight];
- CO_2 savings/impacted flights [Kg/flight],

These variables are the ones directly included in the external benefit model used for the CBA. The relation existing between Operating Costs reduction and time savings is due to the intrinsic nature of this type of costs, as the reduction in route extension directly impacts fuel savings, while savings implied by CO_2 emission reductions are due to the Emissions Trading Scheme being implemented in the European airspace. Additional efficiency-related parameters are impacted by operational changes, such as NOx emissions reductions, having a general impact as cost on the society which is currently not internalised by Airspace Users and hence not included in the model. The mechanism through which operational improvements convert into economic benefits for the airlines is explained in section 4.2.6.

In order to convert daily estimations into annual figures, the same balanced average procedure used for the calculation of impacted traffic was applied, i.e., an average time/fuel/CO_2 savings per flight (TSF/FSF/COSF) was computed by applying the weights A, B and C derived in section 8.2.1, allowing to capture the appropriate degree of representativeness for each sample day. Once annual flight efficiency figures were obtained for the three years, time series for TSF(t), FSF(t) and COSF (t) were derived through linear interpolation as described in the Annexe, section 8.2.4.

The main assumption is that initial savings stemming from FAB operational improvements occur in 2013. Further enhancements are gradually introduced following a linear evolution according to three different rates: 2013-2015, 2015-2020, and 2020-2030.

This reflects the gradual introduction of the route network improvements as if they occurred following a linear function. Modifications and changes into the route network need in fact to be gradually introduced, in order to avoid big changes to the day to day activity of Air Traffic Controllers. This assumption has been considered by operational experts as a realistic modelling approximation, since the introduction of big packages of route modifications is usually avoided for safety reasons.

The results of time, fuel and CO_2 savings per impacted flight are plotted in Figure 16.

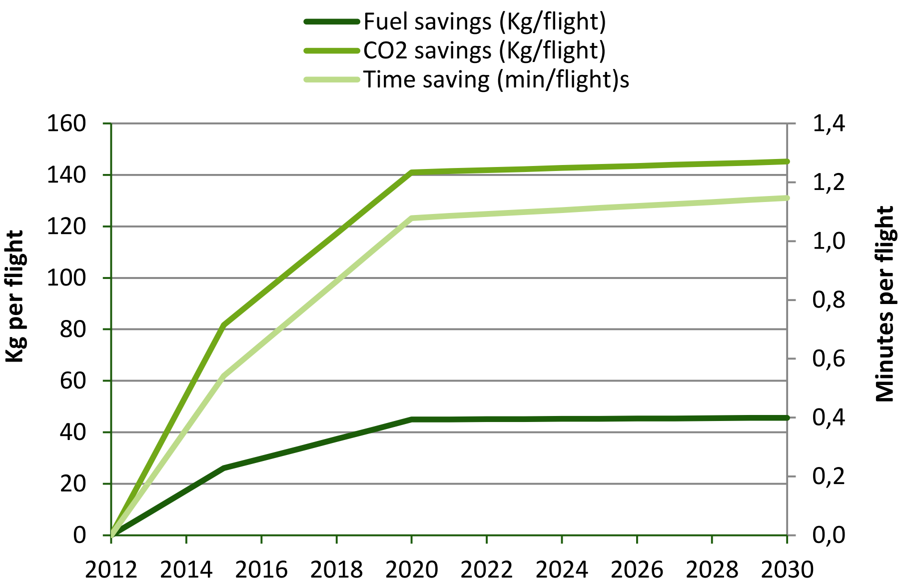

Figure 16: fuel, time and CO_2 savings per impacted flight

4.2.6 Benefit Model

The Benefit Model is strictly related to the Operational Improvement Model and to the Traffic Model, since it calculates the net benefit per impacted flight based on flight efficiency improvements coming out from the Operational Changes Model. In detail, the following sections explain how time, fuel consumption and CO_2 emissions reductions convert into operating, fuel and CO2 (carbon taxes) savings respectively.

4.2.6.1 Operating Costs Savings (OCS)

Operating cost savings are calculated according to the formula reported in Table 10.

Indicator (or output)	Indicator type/Formula	Input variable	Type
Operating cost savings (OCS)	**Variable type**: Uncertainty f(t) **Formula**: $OCS(t) = TSF(t) \cdot IOCT \cdot OCG(t) \cdot ITF(t)$ **Units:** [€/year]	TSF(t): Annual time savings per flight [min/flight]	Defined f(t), t [2013, 2030]
		IOCT: Initial Operating Cost per time unit [€/h]	Defined constant
		OCG(t): Operating cost growth rate	Defined f(t), t [2013, 2030]
		ITF(t): Annual Impacted traffic forecasts [flight/year]	Uncertainty f(t), t [2013, 2030]

Table 10: Operating Cost savings variables

Operating Costs savings result from flight time reductions enabled by the optimized DANUBE FAB airspace network and are calculated per impacted flight. In the context of this CBA, operating costs refer to:

- Maintenance;
- Cabin and cockpit crew;

Apart from these cost elements, fuel and CO_2 costs have been calculated separately to permit a direct analysis on them. This distinction between fuel costs savings (section 4.2.6.2), CO_2 costs savings (section 4.2.6.3) and the rest of operating costs is explained by their different nature and hence analytical treatment required for a reliable and accurate time series computation. On the other hand, other cost items have not been treated, which are usually included in the Direct Operating Cost structure:

- Airport and Navigation charges
- Handling
- Passenger Costs
- Insurance
- Leasing and depreciation

The reason of not including these costs into the model has been discussed and agreed with Airspace Users representatives from IATA. It is based on the consideration that, even if these costs are dependent on flight-time, significant amounts of time savings have to realize to produce the related cost savings. That is to say that the flight time reduction allowed by DANUBE FAB (in the order of one minute per flight impacted) can hardly be used by airlines to add a flight leg into the aircraft schedule, but rather has to be computed as an "aircraft on ground" cost hence not impacting insurance or depreciation of the airframe. Moreover they also depend on a number of other factors such as, airline/aircraft type, internal strategy, local demand, seasonality, etc. and hence excluded from the model.

Airport charges and handling expenditures will not be reduced since these costs depend on the number of movements rather than on flight time. Navigation charges will not be impacted either as they are dependent on the orthodromic distance between the airspace point of entry and point of exit. Insurance costs are generally determined as a percentage of the full aircraft purchase price, whereas leasing and depreciation costs are specified per contract duration.

It follows that only maintenance and crew (cabin and cockpit) costs have been included as the only two factors being impacted by DANUBE FAB flight time reductions. In fact maintenance is a cost that partly depends on the total number of hours flown by the airframe, hence the time-savings sum up to produce monetary savings. Crew costs are also partly dependent on flight-time (wages for cabin and cockpit crew) and hence included in the model, while the non-dependent part (i.e. the allowances) has been excluded.

The Initial Operating Cost (IOCT) for 2012 has been obtained considering the mix of aircraft types as observed in the three characteristic days of traffic (01/01/2010, 02/07/2010 and 19/10/2010).

For each type of aircraft an average number of observations per year was calculated.

Subsequently, a DANUBE FAB Initial Operating Cost (IOCT) for 2012 was obtained considering impacted operating costs data as specified in Annexe, section 8.2.6.For each Aircraft type, the impacted operating cost is an increasing function of time, following an annual growth rate computed according to the airline national inflation rate. Section 8.2.7 in the Annex details the full derivation of the impacted operating cost growth (OCG), consisting of an uncertainty range set between a lower band and an upper band articulated in line with inflation rates of the different DANUBE FAB operating airlines.

Results are plotted in Figure 17. According to IATA expert judgement the lower band of OCG can be considered a null growth rate (0%). This value is motivated by an ever decreasing operating cost associated to more efficient and reliable aircraft technology leading to lower maintenance costs. In addition, a very competitive aviation sector aiming at optimizing operating costs will probably result in tighter margins for crew expenses, causing the medium and long term crew salary growth to lie below national inflations. Inflation would eventually cancel out this decreasing operating cost drift by setting the final OCG growth rate lower band at 0%. On the other end, the upper band is calculated taking into account inflation rate forecasts, as both maintenance and crew costs fluctuations depend on national inflation. In order to use a representative inflation indicator which captures the wide variety of airlines flying through the FAB, carriers are given a inflation rate time series in accordance to their nationality for which the International Monetary Fund (IMF) provides medium term economical forecasts (see Section 8.2.7 for details)

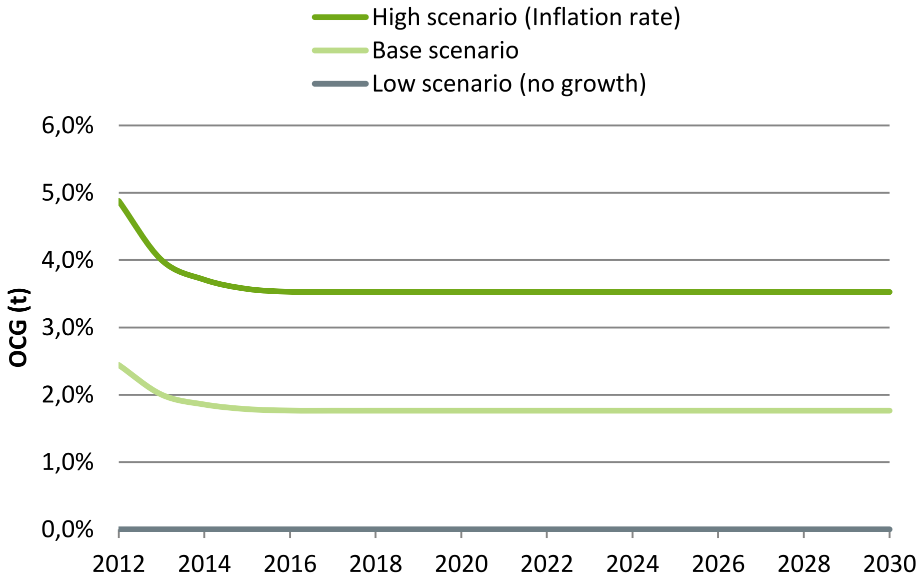

Figure 17: OCG(t)

4.2.6.2 Fuel Cost Savings

The Fuel Costs savings are calculated according to the formula reported in Table 11.

Indicator (or output)	Indicator type/Formula	Input variable	Type
Fuel cost savings (FCS)	**Variable type:** Uncertainty f(t) **Formula**: $FCS(t) = FSF(t) \cdot IFC \cdot FCG(t) \cdot ITF(t) \cdot FCF(t)$ **Units:** [€/year]	FSF(t): Annual Fuel savings per flight [kg/flight]	Defined f(t), t [2013, 2030]
		IFC: Initial Fuel cost [€/kg]	Uncertain constant
		FCG(t): Fuel Cost Growth rate	Defined f(t), t [2013, 2030]
		ITF(t): Annual Impacted traffic forecasts [flight/year]	Uncertainty f(t), t [2013, 2030]
		FCF(T): Fuel Consumption growth rate	Defined f(t), t [2013, 2030]

Table 11: Fuel Costs Savings Model

A base value for fuel price has been considered equal to the 2012 average one published on IATA website.

Variable	Value	Unit	Source
Fuel price	328,8	cts/gal	IATA website April 24th 2012
Density of kerosene	0,81	g/L	Std Inputs 2012
Volume	3,78	L/US Gal	Std Inputs 2012
Exchange rate	1,32	Dollar/€	April 23rd 2012
Fuel Price	760	€/tonne	

Table 12: Initial Fuel Cost calculation

In order to account for the intrinsic unstable nature of crude oil prices due to various facts well beyond of the scope of this CBA, Initial fuel costs (IFC) has been considered as an uncertainty set according to the range given in [1] for 2010 and collected in Table 13.

Variable	Low	Base	High
2010 Fuel (€/kg) [1]	0,37	0,54	0,7
Range ratio	**0,69**	1	**1,30**
2012 Fuel (€/kg)	0,52	0,76	0,98

Table 13: Fuel Cost range calculation

In Table 13, the range ratio captures the low-to-base and high-to-base ratios as specified in [1]. These ratios are used along with the base fuel cost updated for 2012 (from IATA) to compute 2012 low, base and high fuel costs.

The fuel cost growth rate FCG (t) was considered the same as the evolution of crude oil price estimated in [27], providing two different values for the growth rate of Crude Oil price for the periods 2010-2020 and 2020-2030, as indicated in Table 14.

	2010 -2020	2020 – 2030
Crude Oil annual growth rate	1,74	1,59

Table 14: Crude oil annual growth

According to [28], technological development leading to improvements in engines efficiency, aerodynamic efficiency and structural weight are expected to result in about 47% reduction in fuel burn between 2000 and 2050. The variable Fuel Consumption Growth Rate has been introduced to take this fuel consumption decrease into account. If linearity is considered in the technology related fuel burn decrease, the reduction in fuel consumption between 2013 and 2030 is 16%.

4.2.6.3 CO2 cost savings

The CO2 Costs savings are calculated according to the formula reported in Table 15.

Indicator (or output)	Indicator type/Formula	Input variable	Type
Gas emissions cost savings (GECS)	**Variable type**: Uncertainty f(t) **Formula**: $GECS(t) = COSF(t) \cdot ICOC \cdot COCG(t) \cdot ITF(t)$ **Units:** [€/year]	COSF(t): Annual CO2 savings per flight [kg/flight]	Defined f(t), t [2013, 2030]
		ICOC: Initial CO2 cost [€/kg]	Uncertainty constant
		COCG(t): CO2 Cost Growth rate	Defined f(t), t [2013, 2030]
		TF(t): Annual Impacted traffic forecasts [flight/year]	Uncertainty f(t), t [2013, 2030]

Table 15: CO2 Costs Savings Model

It is assumed that the reduction in CO2 emissions is tradable on the market according to the Emission Trading Scheme (ETS). Therefore, emissions reduction can become an income in the event the Airline experiencing the reduction decides to sell it or it can be regarded as a cost avoidance if the Airline abstains from acquiring additional emission permits on the market. The initial price is taken from [3], for a high, base and low scenarios.

Emissions Costs	Low	Base	High
CO_2(€/kg)	10	13	17

Table 16: Initial CO_2 Costs (ICOC)

According to the forecast from 2012 to 2018 given in [3], an average growth rate per year of 1,26% (COCG) is expected for the value of one CO2 permit. The assumption has been made that the same growth rate will apply up to 2030.

4.3 The ANSP model

This section is dedicated to the explanation of the model used to calculate the impact of FAB establishment onto ANSPs as well as a description of the input variables, their values and processing steps.

The diagram in Figure 18 shows the main blocks composing the high level model and interrelationships among them in order to illustrate the way in which the generic EMOSIA ANSP model [16] has been shaped and adapted to fit the purpose of the DANUBE FAB CBA The ANSP model below is embedded in the Overall CBA model and produces an output in the form of Delta services costs, which in turn are an input to the overall benefit model.

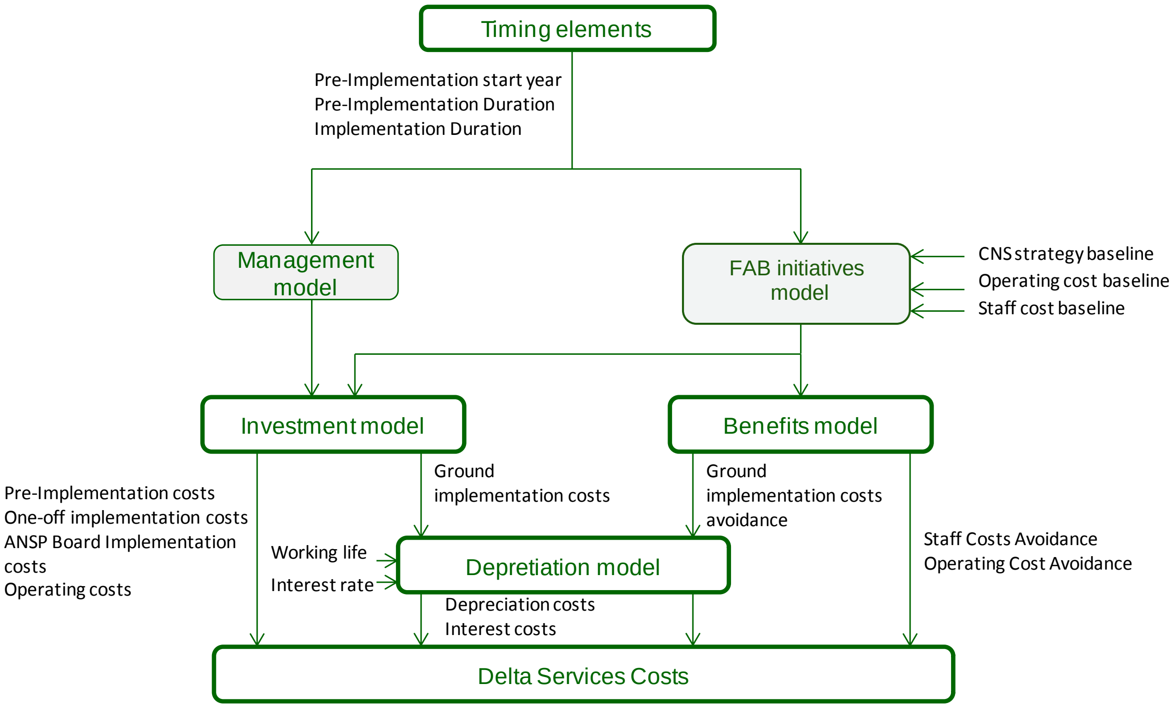

Figure 18: ANSP Model

Table 17 summarizes the different variables appearing in the EMOSIA ANSP model adapted to the current CBA and provides a brief description in the context of the DANUBE FAB CBA. Costs and benefits should be regarded as Delta values with respect to the baseline scenario. In this respect, variables described as not applicable for the DANUBE FAB CBA in Table 17 are those in which changes are not expected with respect to the baseline scenario.

Next sections deal with the detailed description, breakdown and estimation of each of these variables and provide an explanation of the elements included in the ANSP model.

ANSP EMOSIA variable	Variable description for the DANUBE FAB CBA
Timing variables	
Pre-Implementation start year	2008
Pre-Implementation start duration	5 years (2008-2012)
Implementation Duration	18 years (2013 -2030)
Operational Improvements model variables	
CNS Strategy baseline	Foreseen CNS platform acquisition costs for each ANSP in the Baseline scenario.
Operating cost baseline	Foreseen operating cost associated to CNS system operation in the Baseline scenario: It includes costs related to functioning of systems only.
Staff cost baseline	Foreseen costs for personnel (ATCOs and SQSEs) associated to the Baseline scenario.
Investment model variables (costs)	
Pre-implementation costs	FAB related costs from 2008 to 2012
One-off implementation costs	Implementation costs applied one single time for the transition from Baseline to FAB scenarios, in terms of staff training for new operational procedures and airspace design.
ANSP Board Implementation costs	Managerial, governance and staff activities needed for the proper deployment and functioning of FAB during implementation phase.
Operating costs	Not applicable to DANUBE FAB, since no additional costs except the ones related with ANSP board are assumed to be required for the operations of Ground systems
Ground implementation costs	Not applicable to DANUBE FAB, since no costs are assumed to be required for the acquisition of Ground systems
Depreciation model variables	
Interest rate	Not applicable to DANUBE FAB, since no loans are assumed to be required for the acquisition of Ground systems
Working life	CNS systems lifecycle: RADAR, 12 years. DME, 15 years.
Depreciation Costs	Capital costs depreciated during the systems working life
Interest costs	Not applicable to DANUBE FAB, since loans are assumed to be required for the acquisition of Ground systems.
Benefit model variables (savings)	
Ground implementation cost avoidance	Benefits due to common use of CNS systems which lead to acquisition cost avoidance.
Operating cost avoidance	Benefits due to acquisition cost avoidance which lead to reduced operating costs with respect to baseline scenario.
Staff Cost avoidance	Benefits due to more efficient management of human and staff resources (ATCOs and SQSE staff).

Table 17: ANSP model variables summary and high-level description

A set of economic variables are used recursively within the rest of the document. For the period 2010-2015, values for inflation are taken from [6], while for the period 2016-2030 inflation is assumed to be constant.

The exchange rates between National Currencies and Euro are considered fixed for both Countries, in line with their current exchange regimes (Bulgaria has a currency board arrangement while Romania's exchange rate regime is characterized by a managed float).

	Years						
Common economic variable	2010	2011	2012	2013	2014	2015	2016-2030
INF_R (t): Inflation Rate ROMATSA (%)	6,1	6,6	4,5	3,1	2,8	2,8	2,8
INF_B (t): Inflation Rate BULATSA (%)	2,4	4,8	3,7	2,7	3,0	3,0	3,0
$EXCH_R$: Exchange rate ROMATSA (1Eur=)	4,20 RON						
$EXCH_B$: Exchange rate BULATSA (1Eur=)	1,95 BGN						

Table 18: Common economic variables [6]

4.3.1 Timing elements

In the same way than for the airline model, the timing elements are used to describe when costs and benefits are incurred according to the evolution of the DANUBE FAB project.
Pre-implementation start year is 2008, time at which the first analysis were available from the Feasibility Study (Phase 1) of DANUBE FAB project, the first FAB concept was formalized and preliminary evidences of added value were produced, determining the decision to go on with the preliminary design (Phase 2).
The pre-implementation period is assumed to conclude at the end of 2012, when the DANUBE FAB is expected to be formally declared to EC and DANUBE FAB State Agreement to be entered into force.

The implementation period is considered up to 2030. Even if the FAB is expected to continue beyond 2030, the temporal horizon considered in the CBA analysis has been agreed up to 2030.

4.3.2 Depreciation model

This model depreciates the capital amounts taking part in the investment and benefit models. Depreciation should be understood as the allocation of the cost of assets to periods in which the assets are used.

Therefore, the annual depreciation expense is defined as:

$$Annual\ Depreciation\ Expense = \frac{Cost\ of\ Fixed\ Asset - Residual\ Value}{Asset\ lifecycle}$$

Where, the residual asset is usually null because after service retirement the value of the CNS system is negligible.

In the context of this CBA the capital amounts are computed in the form of benefits from CNS systems cost avoidance (coming out from the benefits model). In fact, no capital costs are related to the investment model as no system platform needs to be acquired for the implementation of FAB operational changes. Inputs to the depreciation model are the system lifecycle and the interest rate. The latter parameter is not relevant for the present case since no loans are assumed to be required for the acquisition of ground systems.

As will be seen later, depreciation is applied to ground Implementation costs avoidance, i.e., caused by radar and DME acquisition avoidance.

4.3.3 Investment model

The investment model summarizes the costs from an ANSP perspective, associated with the establishment and operation of the DANUBE FAB. Costs can be broken down into two types according to two different categorizations:

- Non-capital costs which include:
  - All Pre-implementation costs
  - Non capital-Implementation costs: Operating, ANSP Board and One-off implementation costs.

- Capital costs, which include Ground space implementation costs and are also input into the depreciation model.

Pre-implementation costs include all expenses prior to the establishment and deployment of FAB operational changes (i.e. 2013). These costs are attributable to activities required for the setting-up of the project and include all activities related to the FAB prior to the implementation phase starts (2013) and essential for its proper establishment. Activities include financial and economic assessments and budgeting, technical and operational analysis, communication activities, training, human resources and social impact studies, Safety, Quality & Security Management Systems, Legal, Regulatory & Procurement framework and project management activities prior to FAB implementation.
The Working groups costs have been assigned to different initiatives according to Table 19.

Working group	Initiative
Project Management	Management activities
Legal, Regulatory & Procurement framework	Common procurement
Human resources & Social impact	Management
Operational analysis	Airspace design & management and common operational concept
Technical analysis	Common CNS strategy
Training	Harmonized Training system
Safety, Quality & Security Management Systems	Harmonized Safety, Quality & Security Management System
Financial assessment, Economic assessment and Budgeting	Management activities
Communication activities	Management activities
Building issues	Management activities

Table 19: Correspondences between Working Groups and Initiatives

Pre-implementation direct costs applicable from 2008 to 2012 and including effort, missions and contracts costs have been provided by ROMATSA and BULATSA, The amounts for 2008-2010 have been audited, while the ones for 2011 are final but not yet audited and the 2012 reflect the updated budget according to the exerts estimations. BULATSA costs include VAT for the period 2008-2011 and do not include staff cost for 2008 fifty percent of which have been financed by the European Commission (TEN-T) and hence excluded from the model. Pre-implementation costs have been associated with the different benefit initiatives when there was a clear relationship, while they have been included within the category “Management activities” pre-implementation costs when they were due to general management activities.

All pre-implementation costs variables and data are summarized in Table 20 and Table 21. Their definition and relevance will become apparent subsequently once they are associated to their corresponding benefit initiative.

Indicator (or output)	Indicator type/Formula	Input variable	Type
Pre-implementation Costs (PIC)	**Variable type:** Defined f(t) **Formula**: PIC(t) = APC(t)+CCPC(t)+CTPC(t)+SPC(t)+OPC(t) **Units:** [€/year]	APC(t): Annual Airspace Design pre-implementation cost [€/year]	Defined f(t), t [2008, 2012]
		CTPC(t): Annual Common Training system pre-implementation cost [€/year]	Defined f(t), t [2008, 2012]
		CCPC(t): Annual Common CNS pre-implementation costs [€/year]	Defined f(t), t [2008, 2012]
		SPC(t):Annual Harmonized SQSE system pre-implementation costs [€/year]	Defined f(t), t [2008, 2012]
		CPPC: Common Procurement pre-implementation costs [€/year]	Defined f(t), t [2008, 2012]
		OPC(t): Other pre-implementation costs [€/year]	Defined f(t), t [2008, 2012]

Table 20: Pre-implementation variables

		Years				
Pre-implementation cost variable (€)	ANSP	2008	2009	2010	2011	2012
APC(t)	ROMATSA	18839	14241	42118	501369	143581
	BULATSA	26912	6976	26772	334360	66023
CTPC(t)	ROMATSA	0	2126	1218	0	12500
	BULATSA	0	1752	1763	12798	10177
CCPC(t)	ROMATSA	10297	8070	12115	12802	18937
	BULATSA	12398	7862	11992	26249	17520
SPC(t)	ROMATSA	18049	2461	11172	28855	53951
	BULATSA	21755	2221	1453	28933	71084
CPPC(t)	ROMATSA	19441	4943	5662	19878	19250
	BULATSA	24189	8195	4955	12801	19250
OPC(t)	ROMATSA	35331	48627	67958	183427	262555
	BULATSA	47431	59703	50061	196104	230897

Table 21: Pre-implementation costs data applicable to CBA (not covered by TEN-T)

Operating costs include expenditures associated to the operating phase of the Operational Improvements. Because of the broad definition of operating costs in the context of CBA analysis, it is worth specifying the detailed definition in the context of the current CBA. Operating costs include strictly costs of operations associated to the functioning of system platforms required for the implementation of a given FAB operational improvement (maintenance and repair, material, supplies, utilities and other services).

Other costs applicable to operating expenses such as staff and overhead costs are kept outside this category. In detail, staff costs will be treated as a separate category (ANSP Board implementation costs) comprising management, operating and support staff costs for the proper implementation and application of the FAB concept. Overhead costs (including in turn administration personnel and training) will be shared between ANSP Board and one-off costs, the latter including one-off training costs essential for ATCOs familiarization with the FAB concept. Under the operating costs definition aforementioned, no specific costs are identified for the DANUBE-FAB.

ANSP Board Implementation costs apply from the FAB initial implementation capability onwards and include all those managerial, governance and staff activities needed for the proper deployment and functioning of FAB operational concept and associated operational improvements during implementation. ANSP board costs are indeed the prolongation of "Other pre-implementation costs" beyond the start of FAB operations.

One-off Implementation Costs are represented by one-off services, one-off operating start-up costs, and other one-off expenditure for the establishment of the DANUBE FAB. Within the investment model for ANSPs, One-off training activities for ATCOs in operations will be considered necessary due to the introduction of new operating methods and procedures implied by the establishment of the FAB.

Ground space implementation costs are those capital costs leading from the acquisition of new systems and platforms enabling the proper conduction of FAB operations. They are input to the depreciation model. No specific Ground Space Implementation costs are identified in the context of this CBA, as FAB implementation will bring about sharing of CNS systems between Romanian and Bulgarian airspaces and no Ground System Platforms will be required for the implementation of FAB associated Improvements.

For convenience and clearness in the explanations, investments coming out from this model are included in the FAB initiatives model, along with their corresponding benefit initiative.

4.3.4 Benefits model

The benefit model considers the savings in the FAB scenario with respect to the baseline scenario resulting from the FAB initiatives model. For each initiative one specific benefit mechanism is associated, which illustrates the link between activities and monetary impact. Most of these impacts are benefits implied by cost avoidances in the following areas:

- **Staff cost avoidance**, caused by a more efficient use of available human resources, leading to a reduced increase in the number of new staff to be employed in the FAB scenario. This staff cost avoidance affects mainly En Route ATCOs and SQSE personnel.
- **Ground Implementation costs avoidance**, resulting from the operation of common CNS systems and associated potential costs savings stemming from the sharing of surveillance data enabled by a common data communication infrastructure.
- **Operating costs avoidance** related to Ground implementation costs avoidance and associated with the operation costs of the aforementioned CNS systems avoided.

The benefit model embraces the entire CBA timeframe, i.e., 2013<t<2030. To ease the explanations, the benefits resulting from this model are included in the FAB initiatives model, along with their corresponding benefit initiative.

4.3.5 FAB initiatives model

The FAB initiatives model represents, through the use of Benefit initiatives, the impact of all FAB related operational changes on the ANSPs. It interacts with the benefits and investment model and is the major enabler for the description of the ANSPs benefits mechanisms. The five benefit initiatives included in this model are:

1. Airspace design & management and common operational concept;
2. Harmonized training system;
3. Harmonized management systems for SQSE;
4. Common CNS strategy;
5. Common procurement.

In order to support the quantification of costs and benefits associated to each initiative, a benefit mechanism is derived with the structure described in section 4.1.

4.3.5.1 Airspace design & management and common operational concept: Investments and Benefits

Benefit initiative description

The restructuring of Airspace and network as well as the introduction of the FAB Common operational concept imply a pre-implementation cost for Research, development and simulations which initiated in 2008 and will continue till the end of 2012. This cost has been partially financed through TEN-T funds (out of the scope of the CBA) and partially by ROMATSA and BULATSA funds, see Table 22.

The principal focus during the pre-implementation phase has been to re-design airspace regardless of existing boundaries and taking in due account the collaborative processes at the international level. The re-designed airspace and optimised route network has been developed by a specifically tasked DANUBE FAB Airspace Design and Operations Development Expert Group (ADODEG) with the support of EUROCONTROL. The ADODEG comprises civil and military operational experts from both Member States and is responsible for development and evaluation of DANUBE FAB operational concept and airspace improvements.

The route network is in-line with the European ATS Route Network Version-7 (ARN v.7) and the basic structure of airspace has been defined to minimise coordination and increase capacity for an acceptable amount of workload. During the design phase several variants were simulated in real time in one of the most complex simulations ever undertaken within Eurocontrol and demonstrate clearly the feasibility and safety of full implementation.

The result is 95 new and dedicated DANUBE FAB routes, 88 of which are currently agreed for implementation. These routes have been developed throughout the lifetime of the FAB project and they will continue to evolve through the ADODEG group. 41 routes have already been implemented, and a further 26 will be implemented in stages between 2013 and 2020. The remaining routes are currently planned to be implemented after 2020, though they may be implemented earlier or not at all because of a plan to move to free routes across the entire FAB airspace around 2020.

The implementation of free route at national level will begin in the summer of 2014, following a step approach that will depend on the success of free route concept at European level. The extension of free route operations at a FAB level is foreseen for summer of 2016. The two figures below show, on the left, the 88 new routes being implemented up to 2020, and, on the right, the comparison between the fixed route network (red) and free route network (green) planned for implementation around 2020.

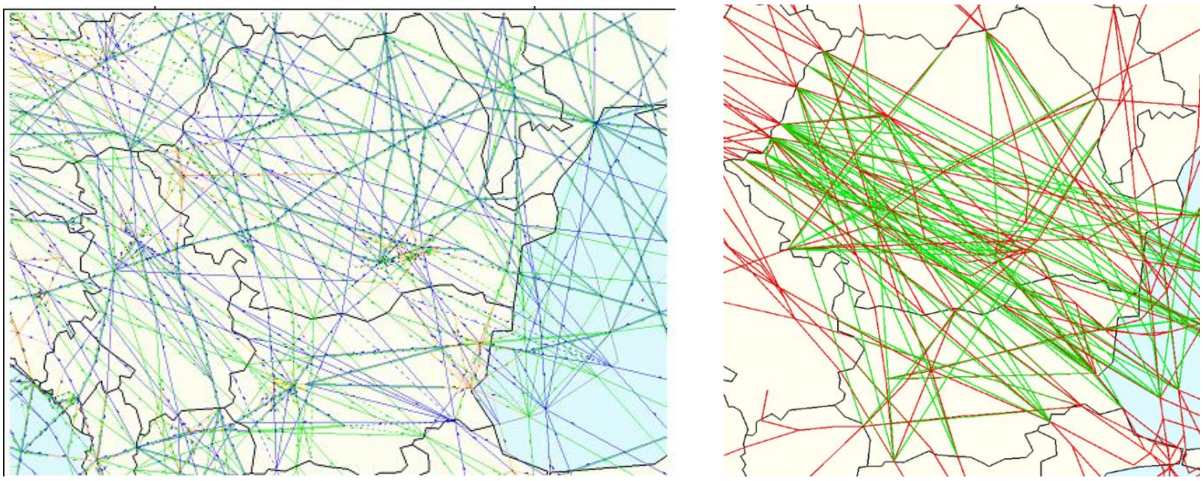

Figure 19: DANUBE FAB new routes (left) and comparison between the fixed routes and free routes

Additional costs with respect to the baseline scenario are foreseen for one-off ATCO training, required prior to the introduction of a change in Airspace or network structure. These improvements are gradually implemented following an evolutionary approach, requiring additional training activities to the ones already programmed during spring sessions.

On the other hand the introduction of the improved airspace and network structure, supported by common ATS/ATM procedures and managed according to the common FAB Operational Concept, allows ATCOs to handle more flights. This in turn will permit reduction of new ATCOs recruitments foreseen for BULATSA and ROMATSA from 2013 with respect to the baseline scenario. The reduced need for ATCOs recruitments will also determine a reduction in the correspondent initial training costs.

Figure 20 illustrates the resulting benefit mechanism.

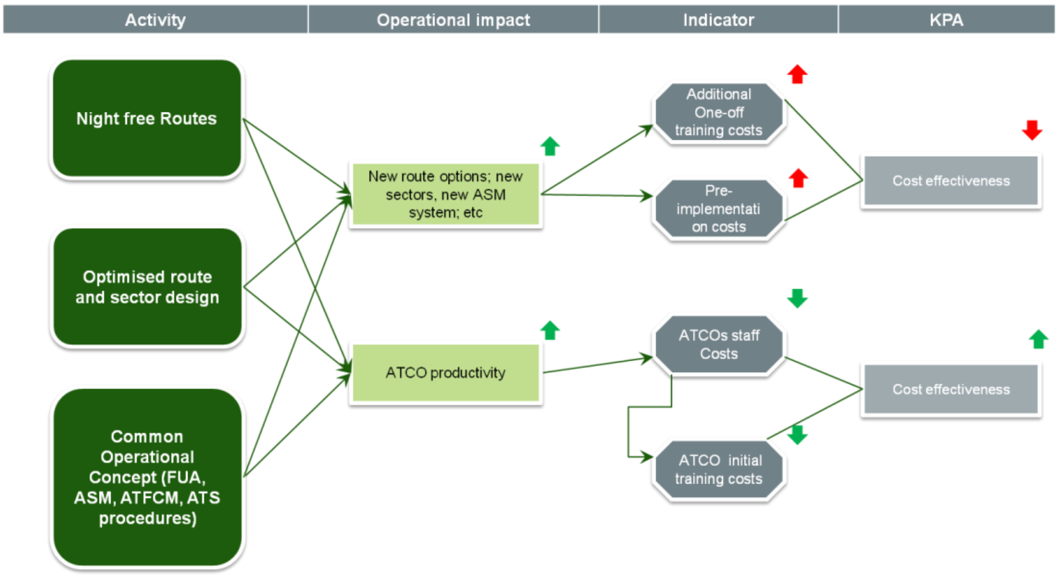

Figure 20: “Airspace design & management and common operational concept" Benefit Mechanism

Pre-Implementation costs

Indicator (or output)	Indicator type
APC(t): Annual Airspace Design pre-implementation cost	**Variable type:** Defined f(t)), t [2008, 2012] **Units:** [€/year]

Table 22: Airspace Design & Management and common operational concept pre-implementation costs variables

		Years				
Pre-implementation cost variable (€)	ANSP	2008	2009	2010	2011	2012
APC(t)	ROMATSA	18839	14241	42118	501369	143581
	BULATSA	26912	6976	26772	3343	66023

Table 23: Airspace design & Management and common operational concept pre-implementation costs data

One-off training implementation costs

As mentioned earlier, One-off training implementation costs are caused by the need of ensuring familiarization of ATCOs in operations with FAB related new operating procedures, network and airspace design. Only ROMATSA is considering additional Type B training courses, while BULATSA is integrating them into regular training.

Indicator (or output)	Indicator type/Formula	Input variable	Type
One-off Training Costs (OTC)	**Variable type:** Uncertainty f(t) **Formula**: OTC(t) = CTB(t)*ATB(t)*TBD(t) **Units:** [€/year]	CTB(t): ROMATSA Daily cost per Type B training course[€/day]	Defined f(t), t [2013, 2020]
		ATB(t): ROMATSA ATCOs receiving Type B training course[ATCOs/year]	Defined f(t), t [2013, 2020]
		TBD(t): ROMATSA Type B training days per year [days/year]	Uncertain f(t), t [2013, 2020]

Table 24: One-off Training Costs (OTC) variables

Table 25 provides one-off training data used for the definition of the variables above:

Variable	Cost per ATCO
CTB (2010)	366€
ATB(2013<t<2020)	28
TBD (2013<t<2030)	High: 3
	Base:2
	Low:1

Table 25: One-off Training Costs (OTC) data

CTB (2010) was provided by ROMATSA training WG and used to derive CTB (t) 2013<t<2030 according to ROMATSA inflation forecasts (INF_R (t)) as specified in Annexe, section 8.2.8.

The number of ATCOs in operations receiving one-off training per year (ATB) was calculated assuming a gradual training programme in line with the deployment of FAB related operational changes (between 2013 and 2020, the end coinciding with the initial implementation of Free Route Airspace (FRA)). One-off training sessions are equally distributed between 2013 and 2020 to train all ROMATSA ATCOs on duty in 2013 (220). This assumption is done to ensure that all ATCOs undergo a single One-off type B training course (lasting between 1 and 3 days) once FAB operational changes directly affect their working methods and practices. New ATCOs enrolled after 2013 are not included in these additional training activities, since it is assumed that the related training can be provided during regular initial or rating sessions. The analytical expression used for calculating ATB(t) is specified in Annexe, section 8.2.8, leading to ATB = 28 ATCOs/year for the period 2013-2020 and null beyond 2020.

Finally, One-off training costs are calculated as specified in Table 24.

Benefits

Benefits due to this initiative result from ATCOs staff cost avoidance and ACTOs initial training cost avoidance and are derived as follows:

ATCOs Staff Cost Avoidance (ASCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
ATCOs Staff Cost Avoidance (ASCA)	**Variable type:** Uncertainty f(t) **Formula**: ASCA(t) = (ACR(t)*ASAR(t) + ACB(t)* ASAB(t))*ACAU **Units:** [€/year]	ACR(t): Annual ATCO Cost ROMATSA [€/year]	Defined f(t), t [2013, 2030]
		ASAR(t): Annual ATCO Avoided ROMATSA [ATCO/year]	Defined f(t), t [2013, 2030]
		ACB(t): Annual ATCO Cost BULATSA [€/year]	Defined f(t), t [2013, 2030]
		ASAB(t): Annual ATCO Avoided BULATSA [ATCO/year]	Defined f(t), t [2013, 2030]
		ACAU: ATCO Cost Avoidance Uncertainty	Uncertainty

Table 26: ATCOs Staff Cost Avoidance Variables

Table 27 presents figures containing data needed for the calculation of variables in Table 26 summarizing the total number of En-Route ATCOs in operations in 2012 and 2030 for the Baseline and FAB scenarios, as estimated by operational experts from the DANUBE FAB WG.

	ROMATSA		BULATSA	
	2012	2030	2012	2030
Total ATCO FAB scenario ($ATCO_{FAB}$)	220	275	95	121
Total ATCO Baseline scenario ($ATCO_{BAS}$)	220	286	95	139

Table 27: Number of ATCOs in 2012 and 2030

From these basic input figures, the annual number of ATCOs avoided was calculated by linear regression between 2012 and 2030. The number of ATCOs avoided (ASAR, ASAB) and the annual ATCO cost (ACR, ACB) are obtained as specified in Annexe, section 8.2.9

Cost avoidance uncertainty (ACAU) is set in line with the traffic variability specified by STATFOR medium and long term forecasts [2] and [3], given that the amount of ATCOs required is strictly dependant on the amount of traffic which needs to be handled. Details on this derivation are specified in the Annexe, section 8.2.9.

Finally, ASCA is found as per the formula in Table 26.

ATCOs Initial training Cost Avoidance (ATCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
ATCOs Initial Training Cost Avoidance (ATCA)	**Variable type:** Uncertainty f(t) **Formula**: ATCA(t)= (ATCR(t)*ANAR(t) + ATCB(t)* ANAB(t))*ATCAU **Units:** [€/year]	ATCR(t): Annual ATCO Initial training Cost ROMATSA [€/ATCO/year]	Defined f(t), t [2013, 2030]
		ANAR(t): Annual New ATCO Avoided ROMATSA [ATCO/year]	Defined f(t), t [2013, 2030]
		ATCB(t): Annual ATCO Initial training Cost BULATSA [€/year]	Defined f(t), t [2013, 2030]
		ANAB(t): Annual New ATCO Avoided BULATSA [ATCO/year]	Defined f(t), t [2013, 2030]
		ATCAU: ATCO Training Cost Avoidance Uncertainty	Uncertainty

Table 28: ATCOs Initial Training Cost Avoidance variables

The following Table presents daily initial training costs per ATCO as per 2012, obtained from training experts and needed for the calculation of ATCR and ATCB. Inflation rate was applied to obtain these costs for the period 2013-2030.

Variable	ROMATSA	BULATSA
Average daily training cost per ATCO	272 €	257 €
Training days per ATCO	60 days	160 days

Table 29: ATCOs Initial Training Cost

ATCR, ATCB, ANAR and ANAB are then calculated as specified in the Annexe, section 8.2.10.

Cost avoidance uncertainty (ATCAU) is set in line with the traffic variability specified by STATFOR medium and long term forecasts [2] and [3], given that the amount of ATCOs required is closely dependant on the amount of traffic which needs to be handled. Details on this derivation are specified in the Annexe, section 8.2.9

Finally, ATCA is calculated as per the formula in Table 26.

4.3.5.2 Harmonized training system model

Benefit initiative description

The existing recruitment, selection and training systems employed by ROMATSA and BULATSA exhibit a number of differences (deriving from differences in operational needs, educational background and other influences such as culture and language), but there are also a number of commonalities and clear opportunities to cooperate to maximise the success rates of selection and training and to improve cost effectiveness.
There are significant similarities in the main content of initial training, but differences arise between additional subjects such as English language, procedural control and radiotelephony. The organisation of unit training differs much across ANSPs and heavily depends on the operational situation and systems employed. A step-by-step approach to harmonisation and cooperation of ATCO training is therefore planned, starting by the following activities:

- The creation of a common basic training syllabus
- The establishment of common selection requirements
- The establishment of common training for specialists involved in selection

In the long term vision, when sufficient harmonisation has been achieved, an initial training (basic and rating) with a common system functionality will be possible only if the costs will be lower, although this is not obvious. There is scope to reduce the total duration of training, amongst other things, by reducing the duration of on-the-job training (OJT), harmonising and shortening pre-OJT, and making initial training more effective. The development towards the long term vision is an evolutionary process of cooperation, partly due to the fact that the changes have to follow developments in other technical and operational areas and partly because by nature making revolutionary changes to training is not possible.

Figure 21 describes the harmonized training system benefit mechanism including ATCOs initial training savings and pre-implementation costs as the two indicators leading to effective cash flows related to this initiative.

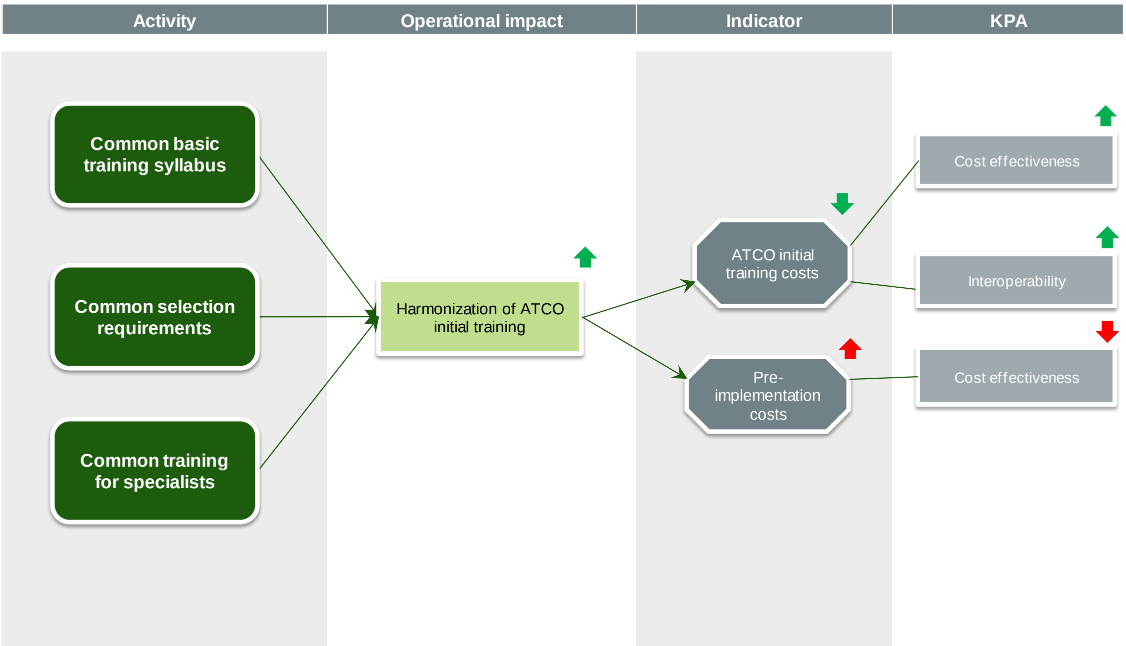

Figure 21: "Harmonized training system" Benefit Mechanism

Pre-implementation costs

Indicator	Indicator type
CTPC(t): Annual Harmonized Training system pre-implementation cost]	**Variable type:** Defined f(t) t [2008, 2012] **Units:** [€/year]

Table 30: Harmonized training system pre-implementation costs variables

		Years				
Pre-implementation cost variable(€)	ANSP	2008	2009	2010	2011	2012
CTPC(t)	ROMATSA	0	2126	1218	0	12500
	BULATSA	0	1752	1763	12798	10177

Table 31: Harmonized training system data

Benefits

Savings due to harmonized training system are derived as follows from the variables summarized in Table 32.

ATCO Initial Training Savings (ATS)

Indicator (or output)	Indicator type/Formula	Input variable	Type
ATCOs Initial Training Savings (ATS)	**Variable type:** Uncertainty f(t) **Formula**: ATS(t) = (ATCR(t) x ANR(t) + ATCB(t) x ANB(t)) x ATSU x BA(t) **Units:** [€/year]	ATCR(t): Annual ATCO Initial training Cost ROMATSA [€/ATCO/year]	Defined f(t), t [2013, 2030]
		ANR(t): Annual New ATCO ROMATSA in FAB [ATCO/year]	Defined f(t), t [2013, 2030]
		ATCB(t): Annual ATCO Initial training Cost BULATSA [€/ATCO/year]	Defined f(t), t [2013, 2030]
		ANB(t): Annual New ATCO BULATSA in FAB [ATCO/year]	Defined f(t), t [2013, 2030]
		ATSU: ATCO Initial Training Savings %	Uncertainty
		BA(t): Benefit % Achieved	Defined f(t), t [2013, 2030]

Table 32: Harmonized training system variables

Table 33 collects baseline scenario data provided by both ROMATSA and BULATSA training WGs experts related to annual number of new ATCOs

Variable	New ATCOs
New ATCOs in Baseline scenario for ROMATSA (2013-2030)	10
New ATCOs in Baseline scenario for BULATSA (2013-2027)	10
New ATCOs in Baseline scenario for BULATSA (2028-2030)	6

Table 33: New ATCOs in baseline scenario data

Then, ANR and ANB are derived from Table 33 data as specified in Annexe, section 8.2.11.

ATCO initial training savings Uncertainty (ATSU) has been estimated by BULATSA training WG experts and take the following values:

Variable	Initial training savings per ATCO
High	2% savings over ATCO training cost
Base	1% savings over ATCO training cost
Low	0% savings over ATCO training cost

Table 34: Initial training savings due to FAB implementation

BA(t) is introduced in order to capture the progressive benefits achieved in terms of harmonized training system, due to the gradual level of harmonization achieved between 2013 and 2017. This period is considered sufficient to achieve the full exploitation of benefits derived from the three activities identified, due to the need of harmonization and alignment activities between national training systems. BA(t) is defined as a ramp function as analytically described in the Annexe, section 8.2.11.

Finally, initial training savings time series (ATS) is found as specified in Table 32.

4.3.5.3 Harmonized management systems for SQSE model

Benefit initiative description

In the areas of Safety, Quality, Security & Environment cost avoidance opportunities are foreseen by the relevant DANUBE FAB Working Group experts, deriving from the sharing of experience and effort for work execution (e.g. preparation of documentation, manuals, amendments, procedures analysis, safety assessments, etc).

It is estimated by these experts that the current and future needs for additional SQSE staff can be mitigated by the cooperation between ROMATSA and BULATSA professionals within the context of the DANUBE FAB. This will be translated into to staff and training costs avoidance in the FAB scenario.

Besides reducing operational costs, cooperation in SQSE will enhance safety awareness, safety culture and the skills of safety experts.

Figure 22 describes the benefit mechanisms associated to this initiative. Savings come in the form SQSE staff and training costs avoidance, whereas pre-implementation costs are the only expense which needs to be accounted.

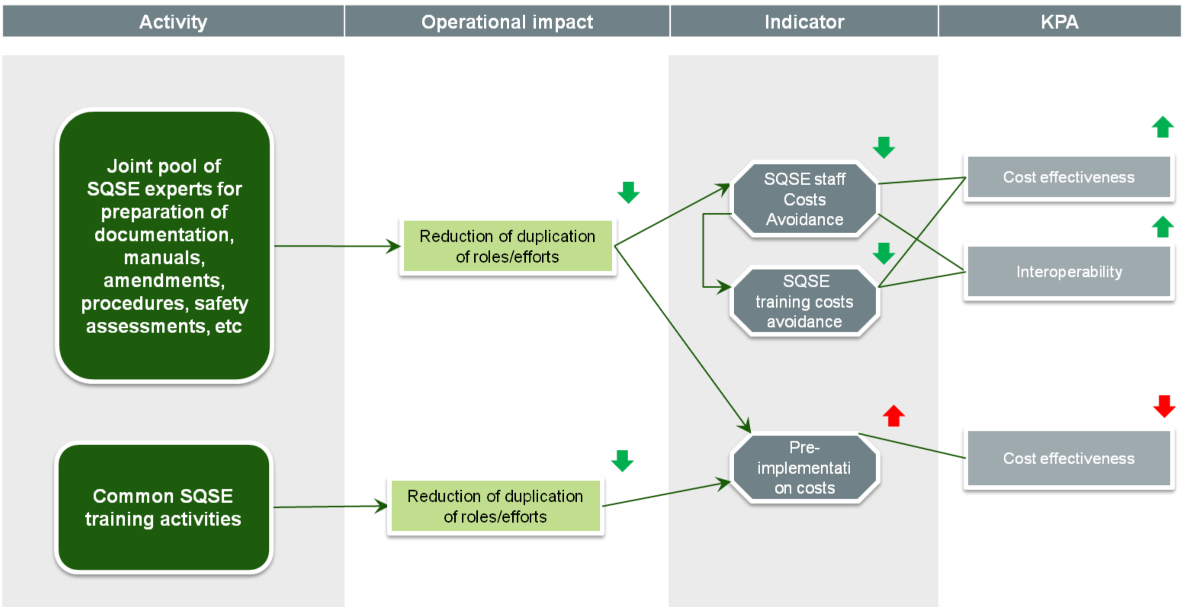

Figure 22: "Harmonized management of SQSE" Benefit Mechanism

Pre-implementation

Indicator (or output)	Indicator type
SPC(t):Annual Harmonized SQSE system pre-implementation costs	**Variable type:** Defined f(t) **Units:** [€/year]

Table 35: Harmonized management systems for SQSE variables

		Years				
Pre-implementation cost variable(€)	ANSP	2008	2009	2010	2011	2012
SPC(t)	ROMATSA	18049	2461	11172	28855	53951
	BULATSA	21755	2221	1453	28933	71084

Table 36: Harmonized management systems for SQSE data

Benefits

Benefits due to this initiative result from the addition of SQSEs cost avoidance plus SQSEs training cost avoidance. Benefits for each initiative are derived as follows:

SQSE Staff Cost Avoidance (SCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
SQSE Staff Cost Avoidance (SCA)	**Variable type:** Uncertainty f(t) **Formula**: SCA(t) = (SCR(t)* SAR(t) + QECR(t)*QEAR(t)+ SECR(t)* SEAR(t)+ SCB(t)* SAB(t) + QECB(t)*QEAB(t)+ SECB(t)* SEAB(t))*SCAU **Units:** [€/year]	SCR(t): Annual Safety Staff Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SAR(t): Annual Safety staff Avoided ROMATSA [employee/year]	Defined f(t), t [2013, 2030]
		QECR(t): Annual Quality & Environment Staff Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		QEAR(t): Annual Quality & Environment Staff Avoided ROMATSA [employee/year]	Defined f(t), t [2013, 2030]
		SECR(t): Annual Security Staff Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SEAR(t): Annual Security Staff Avoided ROMATSA [employee /year]	Defined f(t), t [2013, 2030]
		SCB(t): Annual Safety Staff Cost BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SAB(t): Annual Safety staff Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		QECB(t): Annual Quality & Environment Staff Cost BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		QEAB(t): Annual Quality & Environment Staff Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		SECB(t): Annual Security Staff BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SEAB(t): Annual Security Staff Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		SCAU: SQSE Cost Avoidance Uncertainty	Uncertainty

Table 37: SQSE Staff Cost avoidance variables

Table 38 below shows annual Staff cost data provided by BULATSA and ROMATSA SQSE WGs experts as per 2012. This data is extrapolated for the entire CBA timeframe according to national inflation rates obtained from [6].

Variable	ROMATSA	BULATSA
Safety: Average annual staff cost per employee	SCR(2012): 60000 €	SCB(2012): 51129 €
Quality and environment: Average annual staff cost per employee.	QECR(2012): 56000 €	QECB(2012):33234 €
Security: Average annual staff cost per employee.	SECR(2012): 56000 €	SECB(2012): 29144 €

Table 38: SQSE Staff costs data

Table 39 below shows the projections of numbers of SQSE Staff employed in FAB and Baseline scenarios, according to the forecasts provided by BULATSA and ROMATSA WGs experts for the years indicated. Linear interpolation was then applied to these figures to obtain numbers for each year. Staff avoided is calculated as the difference between the two scenarios.

SQSE type	Variable	ROMATSA					BULATSA				
		2012	2015	2020	2025	2030	2012	2015	2020	2025	2030
Safety	Employees per year in FAB	8	10	12	12	12	6	7	9	9	9
	Employees per year in Baseline	8	12	15	15	15	6	9	11	11	11
	Staff avoided	**SAR(t)**					**SAB(t)**				
		0	**2**	**3**	**3**	**3**	**0**	**2**	**2**	**2**	**2**
Quality and environment	Employees per year in FAB	7	9	10	10	10	5	7	7	7	7
	Employees per year in Baseline	7	9	10	11	11	5	7	7	8	8
	Staff avoided	**QEAR(t)**					**QEAB(t)**				
		0	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**
Security	Employees per year in FAB	3	5	7	7	7	2	4	5	5	5
	Employees per year in Baseline	3	5	7	8	8	2	4	5	6	6
	Staff avoided	**SEAR(t)**					**SEAB(t)**				
		0	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**

Table 39: SQSE staff avoided

SQSE Cost Avoidance Uncertainty (SCAU) was provided by ROMATSA in the form of ±10% variation (high and low scenarios) around the number of SQSE in both FAB and Baseline scenarios. The same uncertainty ranges were considered for BULATSA SQSE figures.

Finally, SQSE staff costs avoidance were calculated using the formula specified collected in Table 37.

SQSE Training Cost Avoidance (STCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
SQSE Training Cost Avoidance (STCA)	**Variable type:** Uncertainty f(t) **Formula**: STCA(t) = (STCR(t)* STAR(t) + QETCR(t)*QETAR(t)+ SETCR(t)* SETAR(t)+ STCB(t)* STAB(t) + QETCB(t)*QETAB(t)+ SETCB(t)* SETAB(t))*STCAU **Units:** [€/year]	STCR(t): Annual Safety Training Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		STAR(t): Annual Safety Training Avoided ROMATSA [employee /year]	Defined f(t), t [2013, 2030]
		QETCR(t): Annual Quality & Environment Training Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		QETAR(t): Annual Quality & Environment Training Avoided ROMATSA [employee /year]	Defined f(t), t [2013, 2030]
		SETCR(t): Annual Security Training Cost ROMATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SETAR(t): Annual Security Training Avoided ROMATSA [employee /year]	Defined f(t), t [2013, 2030]
		SCTB(t): Annual Safety Training Cost BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		STAB(t): Annual Safety Training Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		QETCB(t): Annual Quality & Environment Training BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		QETAB(t): Annual Quality & Environment Training Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		SETCB(t): Annual Security Training BULATSA [€/employee/year]	Defined f(t), t [2013, 2030]
		SETAB(t): Annual Security Training Avoided BULATSA [employee /year]	Defined f(t), t [2013, 2030]
		STCAU: SQSE Training Cost Avoidance Uncertainty	Uncertainty

Table 40: SQSE training cost avoidance variables

Table 41 below shows SQSE staff training costs data as per 2012 provided by BULATSA and ROMATSA SQSE WGs experts. This data is extrapolated for the entire CBA timeframe according to national inflation rates obtained from [6].

Variable	ROMATSA	BULATSA
Safety: Annual training per cost per employee	STCR(2012): 3750 €	STCB(2012):1260 €
Quality and environment: Annual training per cost per employee	QETCR(2012):3700 €	QETCB(2012):3456 €
Security: Annual training per cost per employee	SETCR(2012):4300 €	SETCB(2012): 700 €

Table 41: SQSE staff training cost data

Table 42 below shows the projections of numbers of SQSE Staff trained in FAB and Baseline scenarios, according to the forecasts provided by BULATSA and ROMATSA WGs experts for the years indicated. Linear regression was then applied to these figures to obtain numbers for each year. Staff training avoided is calculated as the difference between the two scenarios.

SQSE type	Variable	ROMATSA					BULATSA				
		2012	2015	2020	2025	2030	2012	2015	2020	2025	2030
Safety	Staff trained per year in Baseline	8	12	15	15	15	6	9	11	11	11
	Staff trained per year in FAB	7	9	11	11	11	6	7	9	9	9
	Annual Staff Training avoided	**STAR(t)**					**STAB(t)**				
		1	**3**	**4**	**4**	**4**	**0**	**2**	**2**	**2**	**2**
Quality and environment	Staff trained per year in Baseline	7	9	10	11	11	5	7	7	8	8
	Staff trained per year in FAB	6	8	9	9	9	5	7	7	7	7
	Annual Staff Training avoided	**QETAR(t)**					**QETAB(t)**				
		1	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**1**
Security	Staff trained per year in baseline	3	5	7	8	8	2	4	5	6	6
	Staff trained per year in FAB	2	4	6	6	6	2	4	5	5	5
	Annual Staff Training avoided	**SETAR(t)**					**SETAB(t)**				
		1	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**1**	**1**

Table 42: SQSE staff training avoided

SQSE training Cost Avoidance (STCAU) was estimated by ROMATSA experts in the form of ±10% variation (high and low scenarios) around the number of trained SQSE staff in both FAB and Baseline scenarios. The same uncertainty ranges were applied to BULATSA SQSE figures.

Finally, SQSE training costs avoidance is calculated using the analytical expression in Table 40.

All benefits under this initiative are represented by cost avoidances. In fact, no benefits in terms of training savings due to the harmonization of SQSE systems and the associated economies of scale is foreseen, since it is considered that any benefits arising from such mechanisms will be overweighed by transport and travel expenditures.

4.3.5.4 Common CNS strategy and planning model

Benefit initiative description

The main benefit activity in this area is the rationalization of CNS infrastructure, optimally deployed within the context of DANUBE FAB operations, instead than at a national one. This implies cost savings stemming from the sharing of surveillance data enabled by a common data communication infrastructure based on IP (already operating) and optimization of the CNS infrastructure deployment on the territory.

Optimal use of technical resources is a mandatory requirement laid down by the Service provision Regulation (Art. 9a.2(d) Regulation No 550/2004), which must be addressed as part of the cost-benefit analysis demonstrating the added-value of a FAB.

Two fundamental documents for assessing the impact of DANUBE FAB on the use of technical resources are the DANUBE FAB – Specification of Technical Services v1 [22] providing an analysis of the current Technical services in ROMATSA and BULATSA, and the "DANUBE FAB Strategic and Harmonisation Plan for CNS Assets" [12] describing the technical services after FAB establishment.

Figure 23 describes the benefit mechanism for this initiative, which results in benefits coming from CNS capital and operating costs avoidance, whereas pre-implementation costs are the only additional required expenditure.

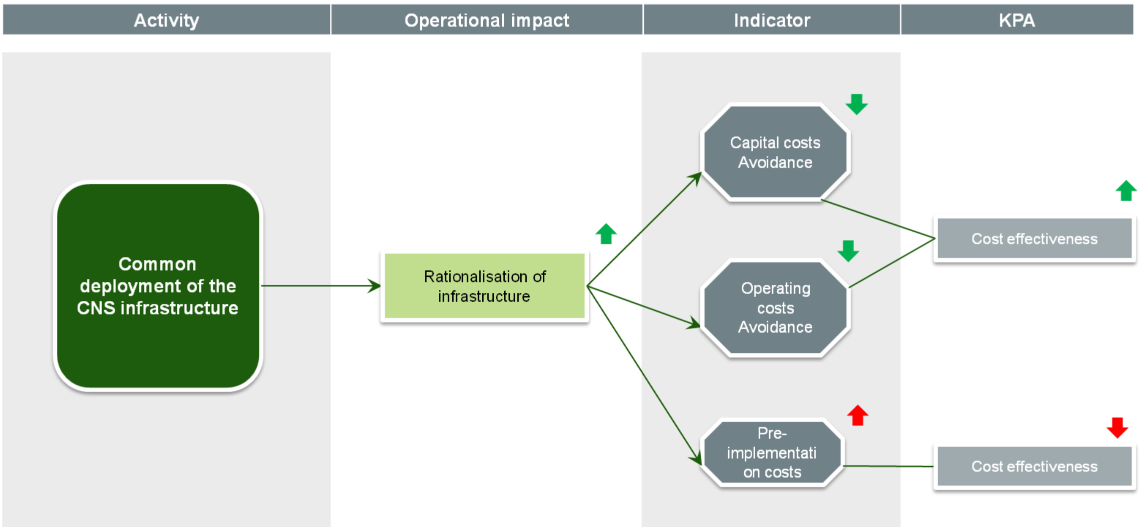

Figure 23: "Common CNS strategy and planning" Benefit Mechanism

Pre-implementation costs

Indicator (or output)	Indicator type
CCPC(t): Common CNS strategy pre-implementation costs [€/year]	**Variable type:** Defined f(t) **Units:** [€/year]

Table 43: Common CNS strategy and planning variables

Pre-implementation cost variable(€)	ANSP	Years 2008	2009	2010	2011	2012
CCPC(t)	ROMATSA	12398	7862	11993	26249	17520
	BULATSA	10297	8071	12116	12802	18938

Table 44: Common CNS strategy and planning data

Benefits

Benefits due to this initiative arise from capital cost avoidance and operating cost avoidance related to the reduced number of system components required in the FAB scenario. These benefits have already started to materialize since the purchase of the correspondent systems has already been avoided, thanks to the initial cooperation undertaken under the DANUBE FAB project umbrella. Benefits for each initiative are derived as follows.

Capital Cost Avoidance (CCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
Capital Cost Avoidance (CCA)	**Variable type:** Defined f(t) **Formula**: CCA = RCA(t)+DCA(t) **Units:** [€/year]	RCA(t): Radar Depreciation Cost [€/year]	Defined f(t), t [2011, 2030]
		DCA(t): DME Depreciation Cost [€/year]	Defined f(t), t [2012, 2030]

Table 45: Capital Cost Avoidance variables

Table 46 shows relevant information on CNS systems avoided due to FAB implementation.

Beneficiary	System	Total capital cost (€)	Operating cost (€/year)	Lifecycle (years)	Implementation year	Number of System units avoided
ROMATSA	Radar	1300000	30000	12	2011	One unit (2011-2023) One unit (2024-2030)
BULATSA	DME (achieving P-RNAV)	780000	81000	15	2012	Three units (2012-2027)
ROMATSA	AFTN optimization		20000		2013	
BULATSA	AFTN optimization		20000		2013	

Table 46: CNS avoided systems information

Capital costs avoided are depreciated during the entire system lifecycle as explained in the depreciation model, section 4.3.2.

Radar cost avoidance RCA(t) results from ROMATSA thanks to the avoidance of purchasing of one radar in 2011, to cover the South-western Romanian airspace and to the coverage and data sharing provided by BULATSA radar system. According to the system lifecycle, a total purchase of two radars will be avoided from 2013 to 2030, the second having only partial impact on the benefits derived from such avoidance, due to a depreciation period extending beyond the CBA timeframe. On the other hand, DME cost avoidance DCA(t) results from 2012 Navigation infrastructure optimization leading to an avoidance of acquiring three DMEs achieving RNAV by BULATSA. The latter avoidance will not have effect after DME lifecycle completion (2027), since it is considered that such technology will be completely replaced by satellite navigation by that time. According to the above considerations, RCA(t), DCA(t) and CCA(t) derivations are specified in the Annexe, section 8.2.12.

Operating Cost Avoidance (OCA)

Indicator (or output)	Indicator type/Formula	Input variable	Type
Operating Cost Avoidance (OCA)	**Variable type:** Defined f(t) **Formula**: OCA = ROCA(t)+ DOCA(t)+ AOCA(t) **Units:** [€/year]	ROCA(t): Radar Operating Cost [€/year]	Defined f(t), t [2013, 2030]
		DOCA(t): DME Operating Cost [€/year]	Defined f(t), t [2013, 2030]
		AOCA(t): AFTN Operating Cost Avoidance [€/year]	Defined f(t), t [2013, 2030]

Table 47: Operating Cost avoidance variables

Radar and DME capital cost avoidance will lead to an associated operating cost avoidance for each unit avoided. In addition, the 2012 AFTN infrastructure optimization will result in at least 20 k€/year per ANSP. Such optimization will consist of the coordinated deployment of contingency positions in each country based on the operational decision and on the result of a specific safety case and CBA for mutual contingency both in Sofia and Bucharest after 2016. The operating cost avoidance variables are defined in the Annexe, section 8.2.12 according to Table 46 data.

4.3.5.5 Common procurement model

Benefit initiative description

Common procurement is an area for cooperation permitted and encouraged by the “DANUBE FAB State Agreement” [15]. Since 2008 common procurement of services has been performed for 4 different contracts, demonstrating the feasibility of application of this function.
From the “DANUBE FAB Strategic and Harmonisation Plan for CNS Assets” [12] it results that a number of investments are foreseen up to 2017 for the procurement of the same technologies by both ANSP, including the following:

- Basic air-ground datalink communication services, planned by both ANSPs for 2015
- Airspace Management Tools (Basic LARA, enhanced LARA and communication support for LARA deployment)

Savings are envisaged by the common procurement of communication services for provision CPDLC over VDL mode 2. No common procurement for the ground system implementation will be realized due to the fact that ROMATSA plans to implement AGDL with a new ATM system, while BULATSA plans to upgrade the current ATM system.

ROMATSA in fact foresees a major investment under the ATM 2015+ program to renew the entire system, while BULATSA foresees upgrades to its current SATCAS. It is however considered by experts from both Countries that the adoption of the same ATM system would be an important step for the DANUBE FAB Operational Concept and would facilitate the implementation of the new requirements stemming from SESAR. Also this will impact contingency and interoperability, thus being an enabler for other benefits. However, since no firm agreement exists on the realization of these common ATM upgrade measures, common procurement of new ATM systems has been left out of the scope of this CBA, leaving the potential monetary savings from joint activities as a future issue to be tackled once more progression towards a common agreement exists on this matter.

Figure 24 describes the benefit mechanism for this initiative, which results in benefits coming from communication services for provision CPDLC economies of scale, whereas pre-implementation costs are the only expense needed to consider.

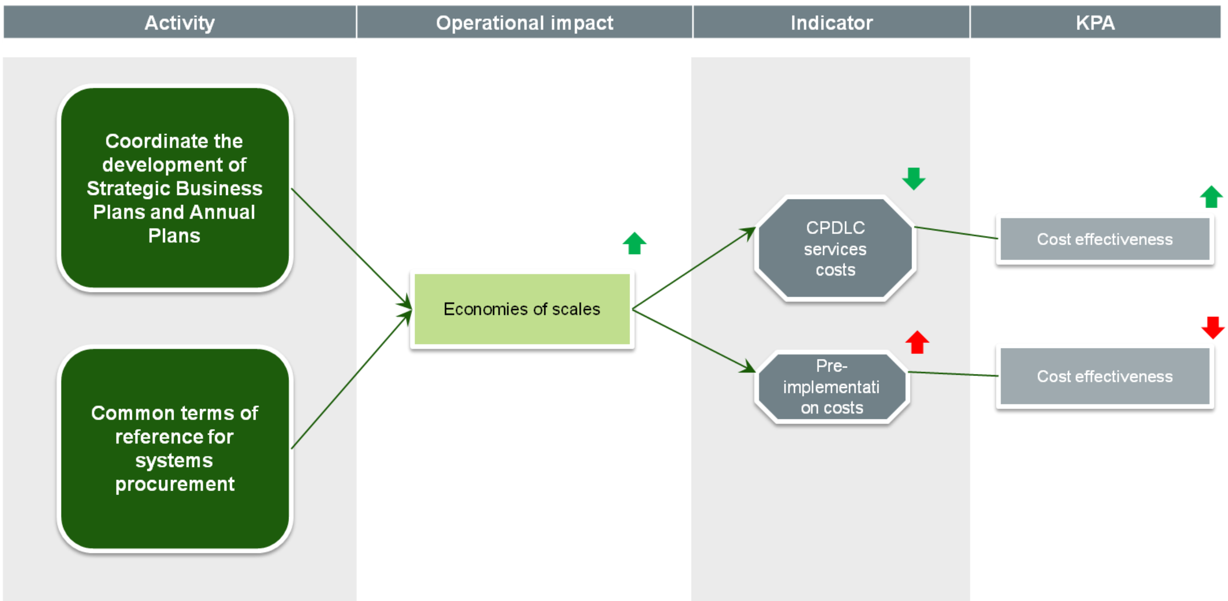

Figure 24: “Common procurement” Benefit Mechanism

Pre-implementation costs

Indicator (or output)	Indicator type
CPPC: Common Procurement pre-implementation costs	**Variable type:** Defined f(t), t [2008, 2012] **Units:** [€/year]

Table 48: Common procurement pre-implementation costs variables

		Years				
Pre-implementation cost variable	ANSP	2008	2009	2010	2011	2012
CPPC(t)	ROMATSA	19441	4943	5662	19878	19250
	BULATSA	24189	8195	4955	12801	19250

Table 49: Common procurement pre-implementation costs data

Benefits

CPDLC Services Cost Savings (CSCS)

Indicator (or output)	Indicator type/Formula	Input variable	Type
CPDLC Services Cost Savings (CSCS)	**Variable type:** Defined f(t) **Formula**: CCS = [CSCB(t) + CSCB(t)]* CSS **Units:** [€/year]	CSCB(t): CPDLC Services Cost BULATSA [€/year]	Defined f(t), t [2013, 2030]
		CCSR (t): CPDLC Services Cost ROMATSA [€/year]	Defined f(t), t [2013, 2030]
		CS : CPDLC Services Savings %	Constant

Table 50: CPDLC Services Cost Savings variables

Operating costs due to communication services for provision CPDLC over VDL mode 2 are in the order of 100 thousands of € per year per ANSP in 2009 [55]. Inflation has been applied to this cost to extent it until 2030.

According to Technical working group experts form BULATSA ROMATSA, the benefits from common procurement of these operating costs will be 20%. The estimation is based on a 20% reduction of the number of sites covering the DANUBE FAB Airspace.

4.3.6 Management model

The management model is a transversal, non-operational area used to describe all those activities needed to ensure appropriate deployment and turn into operations of the FAB concept from 2013 onwards. In detail, the Management Model is concerned with tasks led by the FAB governance structure described in Figure 25.

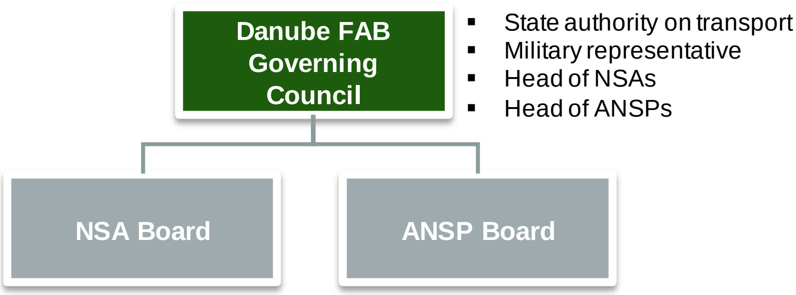

Figure 25: DANUBE FAB Governance Structure

The Governing council will provide oversight and approval of key FAB documentation (annual plans, safety policy, airspace policy, performance plants, etc). Beneath this council will sit the NSA board and ANSP Board which will oversee NSA and ANSP activities, respectively.

The management model will consider expenses derived from activities carried out by the ANSP Board only, the rest of Governing structure related costs being afforded by other institutions. It is important to highlight that ANSP board tasks will not substitute but rather complement activities carried on by the two ANSP at national level. In fact, whereas the production of FAB documentation and the conduction of related organizational activities will require participation of both Romanian and Bulgarian representatives, BULATSA and ROMATSA will keep separate organizational structures undergoing tasks at national ANSP level not affected by FAB implementation. Thus, costs coming out from the Management Model are directly applicable to FAB implementation costs.

Pre-implementation costs

Pre-implementation costs including staff expenses not directly associated to a benefit initiative have been applied to the Management model pre-implementation costs. Indeed, whereas there might not be natural continuation of certain pre-implementation activities included in the management model beyond 2013, it is fair to group all activities carried out before the start of FAB operations and not related to a given initiative, under a common category: “Other pre-implementation activities”. These costs cover the following working areas:

- Project Management
- Human resources & Procurement framework
- Financial assessment, Economic assessment and Budgeting
- Communication activities

Indicator (or output)	Indicator type
OPC(t): Other pre-implementation costs	**Variable type:** Defined f(t), t [2008, 2012] **Units:** [€/year]

Table 51: Other pre-implementation costs variables

		Years				
Pre-implementation cost variable(€)	ANSP	2008	2009	2010	2011	2012
OPC(t)	ROMATSA	35331	48627	67958	183427	262555
	BULATSA	47431	59703	50061	196104	230897

Table 52: Other pre-implementation costs data

ANSP Board Implementation costs

Indicator (or output)	Indicator type/Formula	Input variable	Type
ANSP Board Implementation Costs (ABIC)	**Variable type:** Defined f(t) **Formula**: ABIC(t) = AWC(t)+ATC(t) **Units:** [€/year]	AWC(t): ANSP Board workload costs [€/year]	Defined f(t), t [2013, 2030]
		ATC(t): ANSP Board travel costs [ATCO/year]	Defined f(t), t [2013, 2030]

Table 53: ANSP Board Implementation costs variables

Workload figures have been associated by WG experts to each ANSP Board Implementation activity as specified by the DANUBE FAB State Agreement [15] and summarized in Table 54. This effort was translated into a cost allocated to each ANSP, in accordance to their average annual staff cost. This average staff cost was calculated dividing the total ANSP staff cost by the total number of staff and the figures are from [6].

Costs in the Table below have been used to derive time-dependant costs according to the inflation rate of each country.

ANSP Board Tasks	BULATSA (man days)	ROMATSA (man days)
Ensure the cooperation between the ANSPs for the provision of air navigation services	20	20
Implement the DANUBE FAB common safety policy and propose it for assessment and endorsement to the NSA Board	40	40
Maintain the DANUBE FAB Safety Case and propose it for assessment and endorsement to the NSA Board	40	40
Propose, upon endorsement by the NSA Board, the establishment of cross-border sector(s) to the governing Council for decision	10	10
Adopt and propose to the DANUBE FAB Governing Council for approval the DANUBE FAB common charging policies after consultation with the NSA Board;	30	30
Inform the DANUBE FAB Governing Council upon amendments to the ANSP Cooperation Agreement	10	10
Provide strategic guidance for the development of common systems and the deployment of cost-efficient infrastructure for the provision of communication, navigation and surveillance services	20	20
Approve the measures for achieving optimum airspace utilization proposed by the respective ANSP(s)	40	40
Decide on the joint application of enforced recovery measures against aircraft operators or aircraft owners who have not paid the due charges for air navigation services rendered in the DANUBE FAB airspace.	10	10
Tasks total workload	**BULATSA**	**ROMATSA**
Total man days	**220**	**220**
Full Time Equivalent	**1,00**	**1,00**
Average Annual staff Cost (2013)	46099 €	73232 €
DANUBE FAB ANSP Board Staff cost (2013)	**46099 €**	**73232 €**
ANSP Board Meetings (per year)	**BULATSA**	**ROMATSA**
Number of meetings per year	4	
Attendees from ANSPs	10	10
travel costs per year (500€ per travel and only one ANSP is affected)	20000 €	

Table 54: 2013 ANSP Board tasks and workload

5 Results of the Analysis

5.1 Quantitative results for ANSPs

This section illustrates the main results obtained from the quantitative analysis of the impacts of DANUBE FAB establishment on the ANSPs.

5.1.1 Net Present Value, Internal Rate of Return and breakeven point

Net present value (NPV) is a standard method for the financial appraisal of long-term projects. Used for Capital budgeting and widely throughout Economics, it measures the excess or shortfall of cash flows, in (PV) terms, once financing charges are met.

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

Where,
t - point in time at which a given cash flow occurs, defined equal to 0 at the start of DANUBE FAB pre-implementation phase (2008).
n - DANUBE FAB CBA duration, defined between the pre-implementation start (2008) and the CBA time frame end (2030).
r - the discount rate, which gives the interest rate used to determine the present value of future cash flows.
C_t - the net cash flow (the amount of cash) at time t.

A positive NPV adds monetary value to the stakeholder; conversely a negative one subtracts value while a null NPV neither adds nor subtracts value but the project could nevertheless be accepted because it serves the stakeholder strategy positioning or yields a required rate of return.

In financial theory, if there is a choice between two mutually exclusive alternatives, the one yielding the higher NPV should be selected. The following Table sums up the NPV's various situations.

Case	Meaning	Rational Decision
NPV>0	The investment would add value	The project could be accepted
NPV<0	The investment would subtract value	The project could be rejected
NPV=0	The investment would neither gain nor lose value	This project adds no monetary value. Decision should be based on other criteria, e.g. strategic positioning or other factors not explicitly included in the calculation.

Table 55: Net Present Value definition

The discount rate is the annual rate used to discount the stream of cash flows, to adjust for risk and time value. A good practice of choosing the discount rate is to decide the rate at which the capital needed for the project could return if invested in an alternative venture.

The discount rate has three components:

- A basic, risk free time value of money (TVM) - traditionally of the order of 2.5%
- Compensation for the erosion of the principal by inflation
- A premium for risk.

The discount rate value recommended by EUROCONTROL [1], which has been taken as nominal value for the purpose of this CBA is 4%. This is inflation free and takes only into account TVM and risk premium. The assessment of the risk premium depends on the judgement of the investor and could only be analysed over a portfolio of investments. In the case of investment in an air traffic management system, the risk being evaluated is the risk that the system will operate successfully and generate the benefits expected. It is not related to the commercial viability of aircraft operators using the system.

The NPV calculation is very sensitive to the discount rate: a small change in the discount rates causes a large change in the NPV. Therefore a specific sensitivity analysis is provided in the following section to establish this impact.

The internal rate of return (IRR) on an investment or project is the "annualized effective compounded return rate" or "rate of return" that makes the NPV of all cash flows (both positive and negative) from a particular investment equal to zero.

In more specific terms, the IRR of an investment is the discount rate at which the net present value of costs equals the net present value of the benefits.

The break-even point is the point at which the total amount of costs and of revenues is equal: there is no net loss or gain. The financial method of calculating break-even, called value added break-even analysis is used to assess the feasibility of a project.

Table 56 and Figure 26 summarise the ANSPs internal values for NPV for each initiative and for the overall FAB scenario. The discount rate is applied from 2008 when the investment started for the ANSPs.

It is possible to appreciate the positive added value implied by all the benefit initiatives, which are enabled by the management activities constituting a necessary cost to be afforded both during the pre-implementation and implementation phases. The main contribution to the NPV is due to the “Airspace design & management and common operational concept”, where the benefits are mainly due to the increase of ATCO productivity implying a decrease in the future needs for new ATCOs to be hired and the consequent avoidance of related staff and training costs.

A similar reason lies behind the benefits introduced by the “Harmonized SQSE management system”, where the establishment of a joint pool of SQSE experts also leads to staff and training costs avoidance.

The “Common CNS strategy” gives also substantial benefits which would alone outweigh the the costs implied by all the DANUBE FAB Management activities.

Common procurement and Harmonized training have a low economic impact, which is mainly justified by the conservative assumptions made about the scope of activities to be undertaken in these areas. In fact only the activities already planned and agreed by ANSPs have been retained and analyzed in this CBA.

Initiatives NPV and Costs (€)	BULATSA	ROMATSA	DANUBE FAB
Airspace design	10 478 784	4 904 017	15 382 801
Harmonized SQSE	1 454 830	2 844 259	4 298 124
Common CNS	1 621 551	2 151 365	3 772 917
Common procurement	201 948	215 288	417 236
Harmonized training	17 993	4 473	22 466
Management activities	-1 238 952	-1 614 096	-2 853 047
Total NPV	**12 535 190**	**8 505 306**	**21 040 497**
IRR	**33%**	**25%**	**29%**
Break Even Point	**2016**	**2018**	**2017**

Table 56: DANUBE FAB results

Figure 26 show the NPV distribution between the different benefit initiatives and costs for each ANSP and for the overall DANUBE FAB. The main contribution on the NPV is due to “Airspace design & management and common operational concept”, followed by “Harmonized SQSE system” and “Common CNS Strategy“. The benefits are mainly due to the increase of ATCO productivity that leads to ATCO and training avoidance and SQSE joint pool of experts that also leads to staff and training avoidance. Common procurement and Harmonized training have a low economic impact but the assumptions are very conservative.

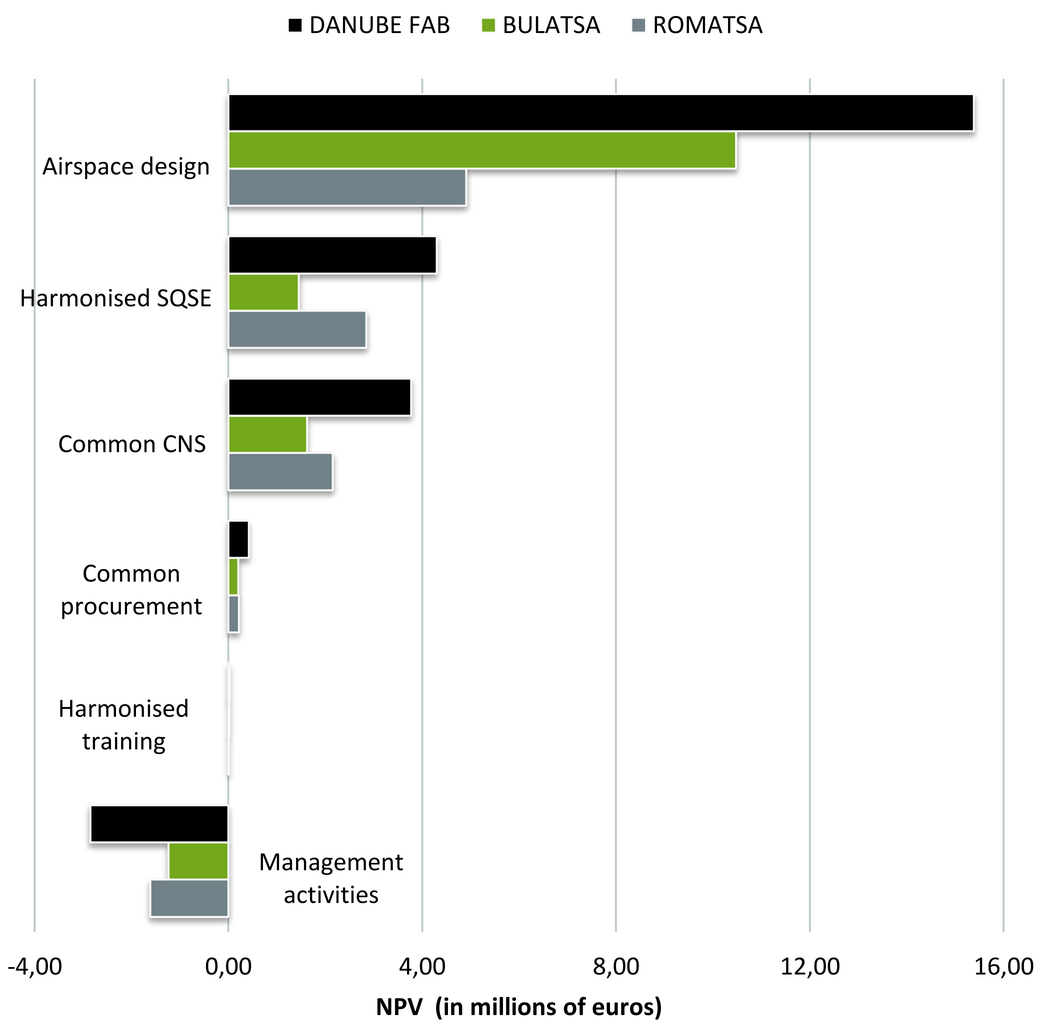

Figure 26: DANUBE FAB NPV distribution

The following graphs presented from Figure 27 to Figure 33 include the cumulated discounted cash flow analysis from 2008 to 2030, related with each benefit intiative separately.

The “Airspace design & management and common operational concept” benefit initiative gives an NPV of 10,5 M€ for BULATSA and 4,9 M€ for ROMATSA, for a total of 15,4 M€, as shown in Figure 27. The difference in NPV between both ANSPs is explained by two facts. Firstly, for the period 2013-2030 BULATSA expects to reduce the need of 18 new ATCOs between 2013 and 2030 whilst ROMATSA expects to reduce the need of 11 new ATCOs during the same period of time. Secondly, BULATSA does not consider that the reorganisation of the airspace and modifications in staff working procedures will imply additional conversion training for ATCOs compared to the baseline scenario. In addition, ROMATSA pre-implementation costs approximately double the amount of BULATSA pre-implementation investments. Overall, it results that the break-even point related to this specific initiative is longer for ROMATSA (2020) than for BULATSA (2016).

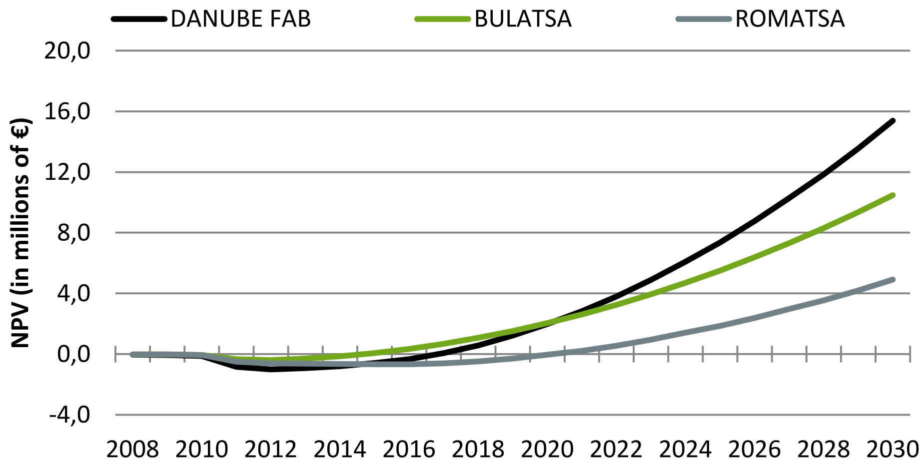

Figure 27: Airspace design & management and common operational concept NPV

“Harmonized management of SQSE” benefit initiative gives an NPV of 1,5 M€ for BULATSA,1,8 M€ for ROMATSA for a total of 4,3 M€, as shown in Figure 28. In this case the difference between both ANSPs is due to the combination of more staff avoided with higher associated costs in ROMATSA than in BULATSA while keeping very similar pre-implementation costs. The break-even point for this specific initiative is reached in 2014 for both ANSPs. A high rate of return is caused by low pre-implementation investments in comparison with the benefits achieved. In fact, investments will be only required for the coordination between ANSPs to establish a “Harmonized management of SQSEs”, whereas significant benefits will result from an efficient harmonization of SQSE working procedures and use of resources leading to the reduction of new SQSE staff needs.

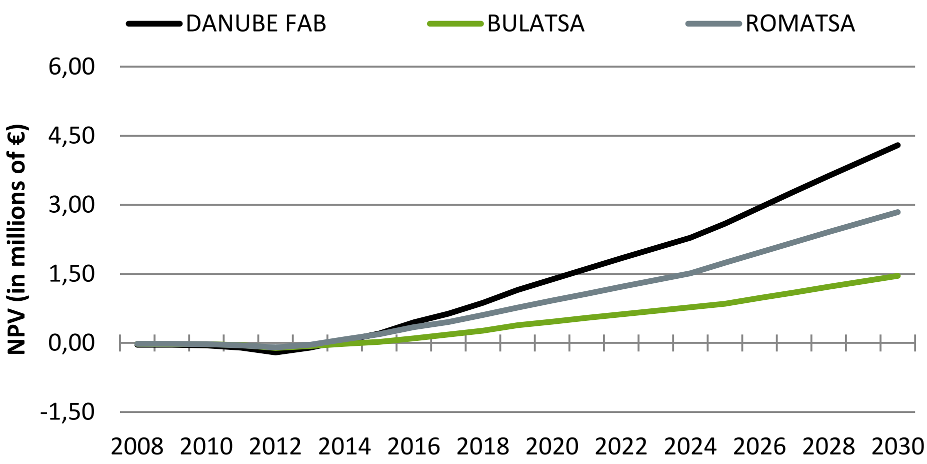

Figure 28: Harmonized management of SQSE NPV

The “Common CNS strategy and planning” benefit initiative gives an NPV of 1,6 M€ for BULATSA, 2,2 M€ for ROMATSA for a total of 3,8 M€, as shown in Figure 29. BULATSA benefits are generated by the avoidance of three DMEs with a lifecycle of 15 years (from 2012 to 2027). This circumstance is reflected in the Figure, by the slope change of BULATSA NPV in 2027. ROMATSA savings are explained by the avoidance of one radar in service during the entire CBA time frame. A very favourable rate of return and early break-even point in 2011 are implied by significant capital and operating costs avoidance requiring low investment, the latter only needed for the coordination between ANSPs and technical anlaysis work.

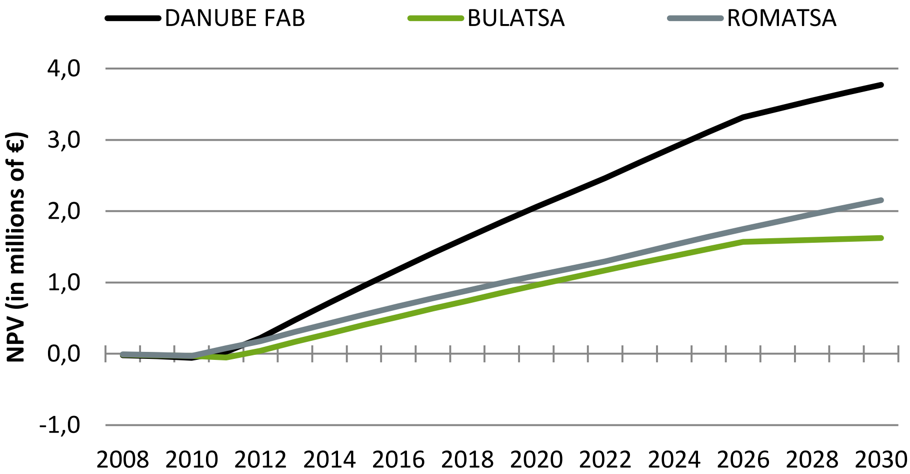

Figure 29: Common CNS strategy and planning NPV

The “Common procurement” benefit initiative gives an NPV of 0,20 M€ for BULATSA and 0,21 M€ for ROMATSA for a total of 0,42 M€, as shown in Figure 30. Savings are related to the common procurement of communication services for provision of CPDLC over VDL mode 2 from 2015, which has been identified as a highly realistic activity by both partners. Savings for both ANSPs are very similar given that the reduction of the number of sites covering the DANUBE FAB Airspace is equally distributed between both. The break-even period for this specific initiative is 2017.

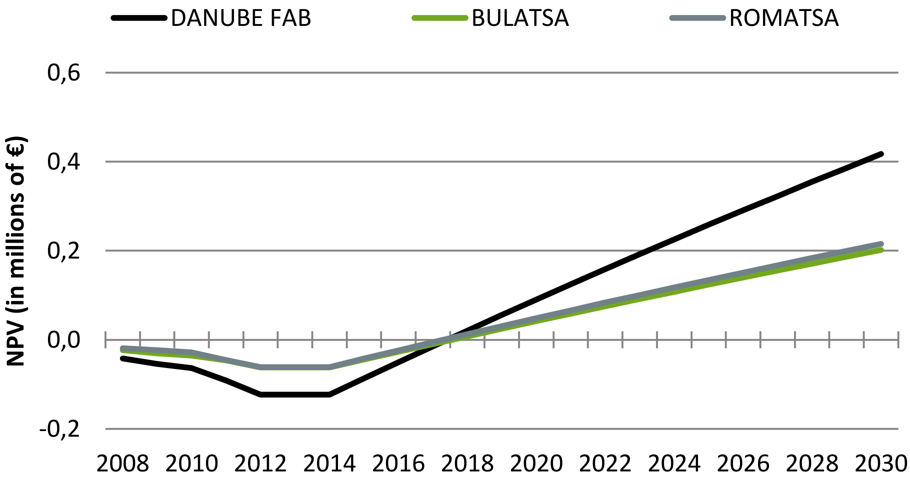

Figure 30: Common procurement NPV

The “Harmonized training system” benefit initiative gives an NPV of 18,0 K€ for BULATSA and 4,5 K€ for ROMATSA for a total of 22,5 K€, as shown in Figure 31. The low rate of return and long payback period for this initiatives are due to a conservative estimate of 1% savings achieved only on ATCOs initial training activities, due to a basic harmonization of the two systems. Overall, the contribution of the “Harmonized training system” to the overall NPV is very limited, representing about 0.1% of the total DANUBE FAB related savings.

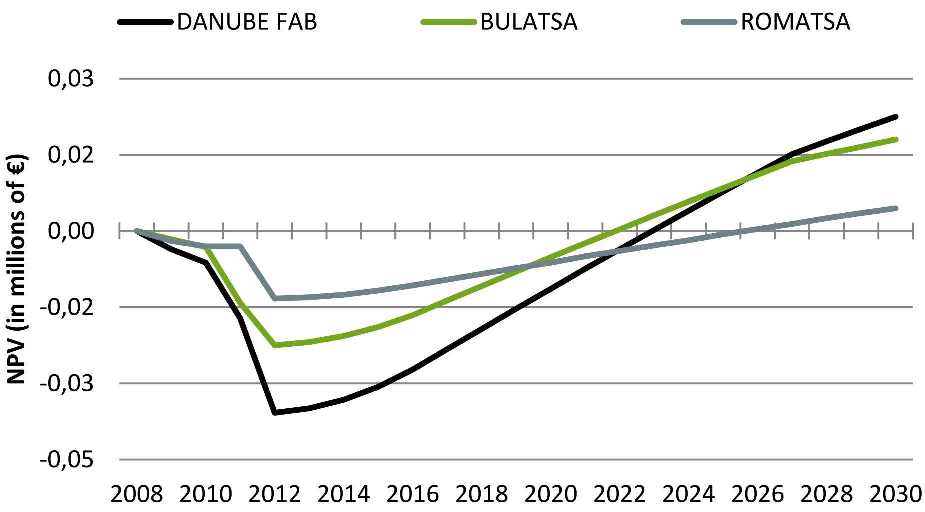

Figure 31: Harmonized training system NPV

The “Management activities” give an overall negative NPV equal to - 1,2 M€ for BULATSA, -1,6 M€ for ROMATSA for a total of -2,8 M€, as showed in Figure 32. “Management activities” include all the activities needed during pre-implementation such as management or communication as well as the ANSP Board activities necessary once the FAB is established. Only 50% of the pre-implementation costs were taken into account as they are not supported by the European Commission. The detailed tasks of the board are explained in section 4.3.6.

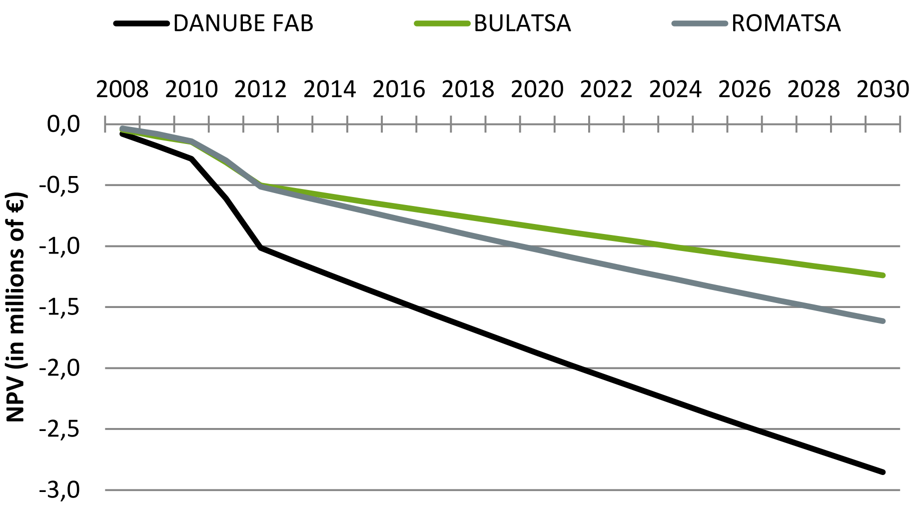

Figure 32: Management activities NPV

Figure 33 shows the total NPV for all initiatives in the timeframe 2008-2030: It equals 12,5 M€ for BULATSA and 8,5 M€ for ROMATSA for a total of 21,0 M€. The DANUBE FAB implementation has a very positive added value with a short break even point in 2017. The added value is still prove with pessimistic values and a higher discount rate, please refer to next section "Sensitivity analysis"

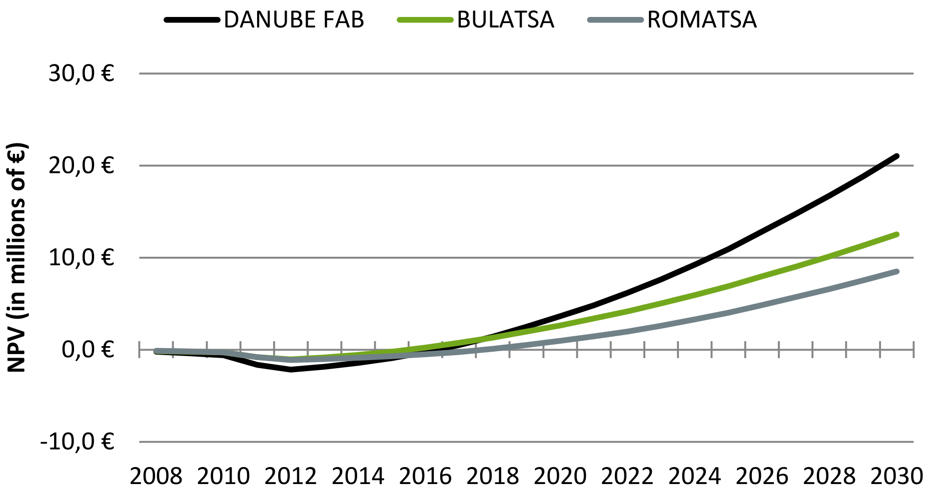

Figure 33: Overall DANUBE FAB ANPs NPV

5.1.2 Sensitivity Analysis

In the EMOSIA model, the variables to which a range can be associated are called uncertainties.

One of the main benefits of the EMOSIA approach is the possibility of taking account the uncertainties in the projected investment, by giving a range of values instead of a single value to some variables modelled. These ranges can be further analysed in a Sensitivity Analysis.

This shows how much an input variable contributes to the variation of the output one (the NPV in this case), all the others being constant at their nominal value.

Sensitivity analysis with Tornado diagrams gives a precious guidance regarding which are the topics and variables which are worth investigating more.

Figure 34 shows the sensitivity of the discount rate on the NPV, when this is changed between 4% and 8%. The value of 4% is the one suggested in [1] and used to calculate the results of this analysis, while the value of 8% is considered as an upper bound, since the long term interest rates for Government bonds rates are 7,02% for Romania and 5,30% for Bulgaria (European Central Bank - Jan 2012). With a discount rate equal to 8%, the NPV is equal to 10,6 M€ for the overall FAB, 6,5 M€ for BULATSA and 4,1 M€ for ROMATSA. The DANUBE FAB implementation still has an added value in this case.

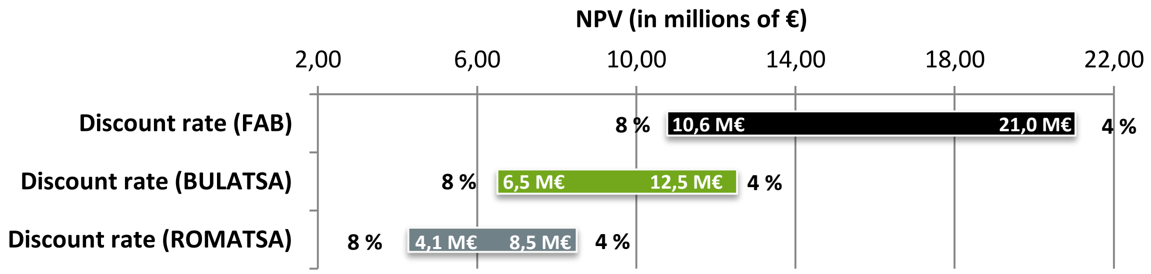

Figure 34: Discount rate tornado diagram

Figure 36 to Figure 37 show the tornado diagram explaining the impact of the uncertain variables on the final NPV for each ANSP and for the DANUBE FAB. For this study, the uncertainties that were taken into account are:

- **ATCOs avoided** due to “Airspace design & management and common operational concept”
- **SQSE staff avoided** due to “Harmonized management of SQSE”
- **Additional conversion training days** due to “Airspace design & management and common operational concept”
- **Savings in initial training** due to “Harmonised training”

The uncertainties impacting most the NPV are the number of new ATCOs and the number of SQSE staff avoided thanks to the related benefit initiative. This result is reasonable since “Airspace design & management and common operational concept” and “Harmonized management of SQSE” are the initiatives that contribute most to the NPV.

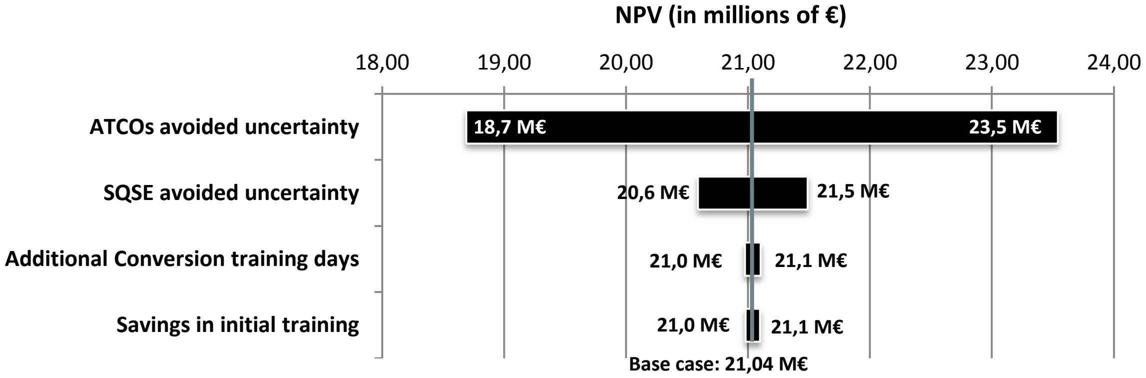

Figure 35: DANUBE FAB tornado diagram

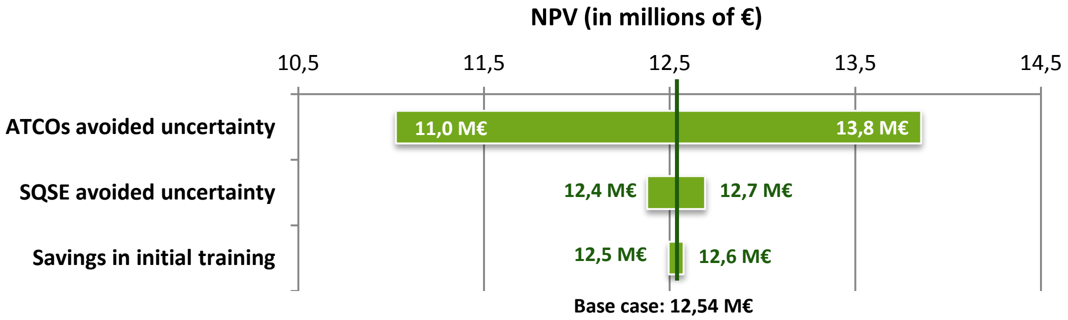

Figure 36: BULATSA Tornado diagram

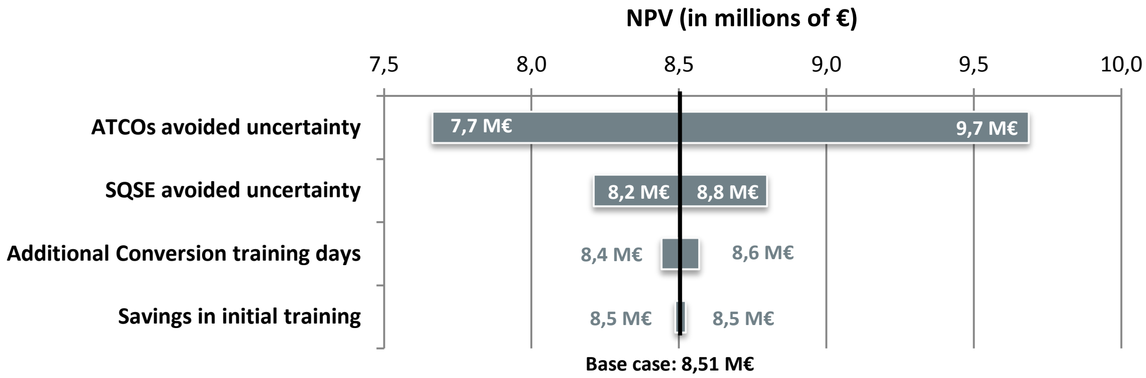

Figure 37: ROMATSA Tornado Diagram

5.1.3 Risk Analysis

Risk Analysis not only allows identification of the uncertainties to which the outcome is sensitive, but also enables an estimate of the extent to which an uncertainty could change a decision (sensitivity of the decision). Rather than using single value estimates, the technique requires an estimation of the likely range of values.

A judgement must be made as to whether there is a critical level of certain parameters which must be achieved.

To complement the sensitivity analysis through tornado diagrams, Table 57 presents the NPV variability resulting from three different situations:

- Worst case scenario: all the uncertainties assume the lowest value in their distribution at the same time
- Nominal scenario: all the uncertainties assume their base values, this coincide with the results presented in the report
- Best case scenario: all the uncertainties assume the highest value in their distribution at the same time

Scenario	Discount rate 4%	Discount rate 8%
DANUBE FAB	**NPV in M€**	
Best case	24,1	12,2
Nominal case	21,0	10,6
Worst case	18,1	9,1
BULATSA		
Best case	14,1	7,3
Nominal case	12,5	6,5
Worst case	10,8	5,6
ROMATSA		
Best case	10,1	4,9
Nominal case	8,5	4,1
Worst case	7,3	3,5

Table 57: Uncertainties impact on ANSPs

Figure 38 presents the Danube FAB NPV for the three different uncertainty scenarios, with a discount rate of 4% and 8%. The comparison between the two graphs shows that discount rate has a very low impact in the breakeven point. In the worst case scenario (low values with a 8% discount rate) the NPV for the Danube FAB is still positive with 9,1 M€.

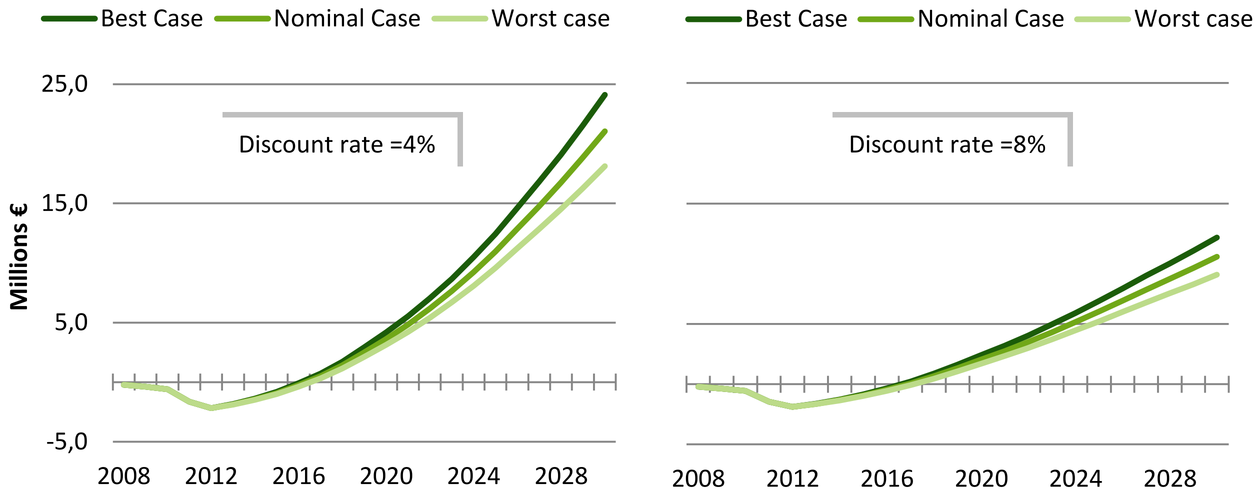

Figure 38: Uncertainties impact on ANSPs NPV

Figure 39 collects the cumulative probability of a specific DANUBE FAB NPV value to materialize, reflecting the impact of the uncertainty variables to the overall variability by quantifying the risk associated to each NPV value. The nominal NPV value of 21M€ is associated to a 50% probability value, resulting from the fact that the distribution of probability of the input variables is very much centred and symmetric with respect to the base value. This indicates that the probability for a lower than nominal NPV to materialize is practically equivalent to the probability for a higher than nominal one.

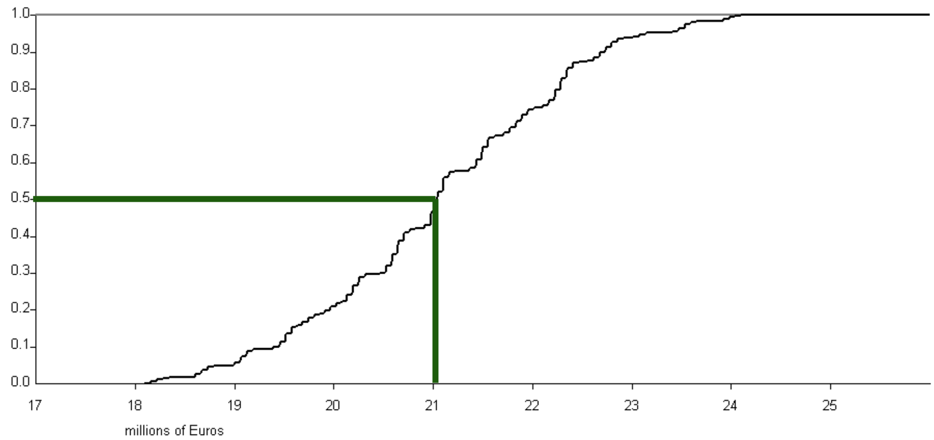

Figure 39: Danube FAB NPV Cumulative probability

5.2 Quantitative results for Airlines

This section illustrates the main results obtained from the quantitative analysis of the impacts of DANUBE FAB establishment on the Airlines.

5.2.1 Net Present Value

Please refer to section 5.1.1 for explanations on NPV calculations.

Figure 40 presents the Net Present Value for Airspace Users which gives an added value of 570 M€. The discount rate is applied from 2008, coinciding with the time at which the investment started for the ANSPs and to maintain consistency. The NPV for Airlines is positive since the start of DANUBE FAB operations in early 2013, due to the fact that no specific pre-implementation and implementation costs are foreseen for this stakeholder category.

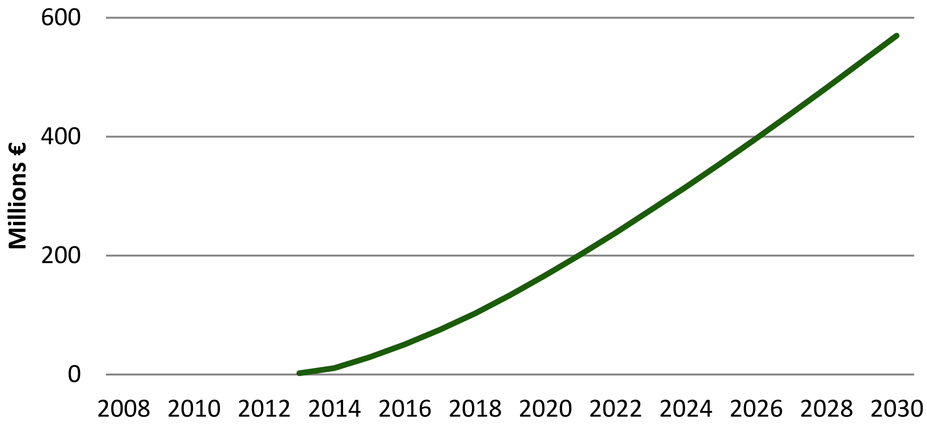

Figure 40: DANUBE FAB NPV for Airspace Users

Fuel savings represent the most important savings with a 64% share, followed by Operating Cost savings with 32% of the total and finally CO_2 savings that only represent 3% of the total. Figure 41 graphically depicts this distribution of savings.

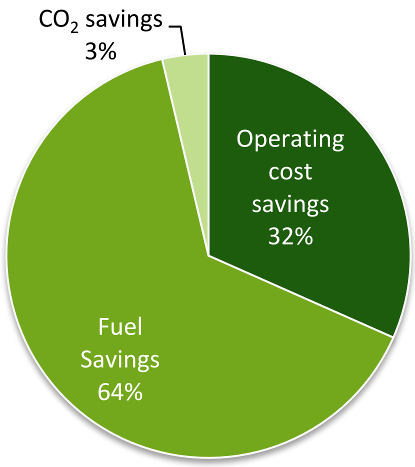

Figure 41: Airlines Operational improvements NPV distribution

5.2.2 Sensitivity Analysis

Please refer to section 5.1.2 for the details on sensitivity analysis methodology.

Figure 42 shows the sensitivity of the discount rate on the Airlines' NPV, when this is changed between 4% and 8%. The value of 4% is the one suggested in [1] and used to calculate the results of this analysis, while the values of 8% is kept for consistency with respect to the sensitivity analysis for ANSPs and with respect to other CBAs in ATM, since historically this was the standard values suggested by EUROCONTROL . The NPV for Airlines varies from 312 M€ to 570 M€.

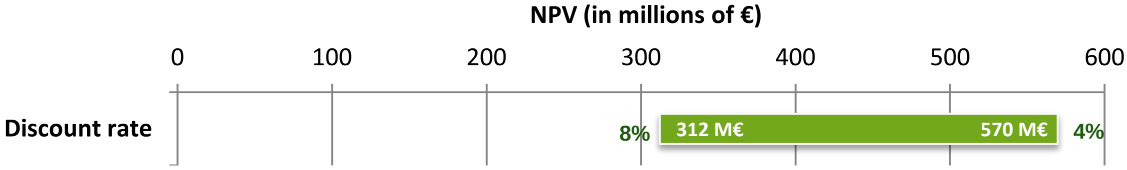

Figure 42: Sensitivity of the NPV to the discount rate modifications

Figure 43 shows the tornado diagram explaining the impact of the uncertain variables on the final NPV for Airspace Users. The uncertainties impacting the NPV in a greatest extent are the initial Fuel Costs and the traffic growth, this latter determining the number of flights impacted:

- For the Fuel cost, NPV varies between 452 M€ and 678 M€
- For the flights impacted, NPV varies between 496 M€ and 643 M€.
- For Operating Costs, NPV that varies between 536 M€ and 612 M€
- For CO_2 Costs, NPV that varies between 565 M€ and 576 M€

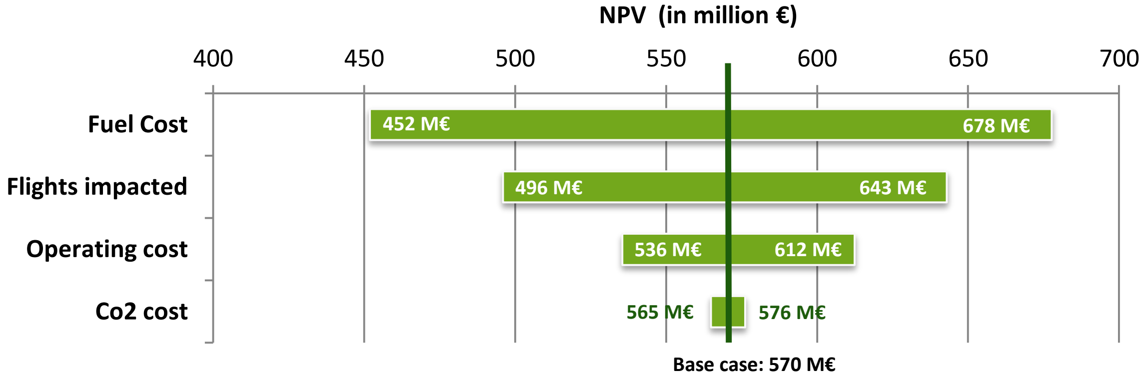

Figure 43: Sensitivity of the NPV to the uncertainties in the model

5.2.3 Risk Analysis

Table 58 presents the NPV variability resulting by considering three different situations:

- Worst case scenario: all the uncertainties assume the lowest value in their distribution at the same time
- Nominal scenario: all the uncertainties assume their base values, this coincide with the results presented in the report
- Best case scenario: all the uncertainties assume the highest value in their distribution at the same time

Scenario	Discount rate 4%	Discount rate 8%
Best case	821 M€	446 M€
Nominal	570 M€	312 M€
Worst case	360 M€	200 M€

Table 58: Uncertainties impact on Airspace users

Figure 44 presents the Airspace users NPV for the different scenarios with a discount rate of 4% and 8%. In the worst scenario (low with an 8% discount rate) the NPV for them due to DANUBE FAB establishment is still positive with 190 M€.

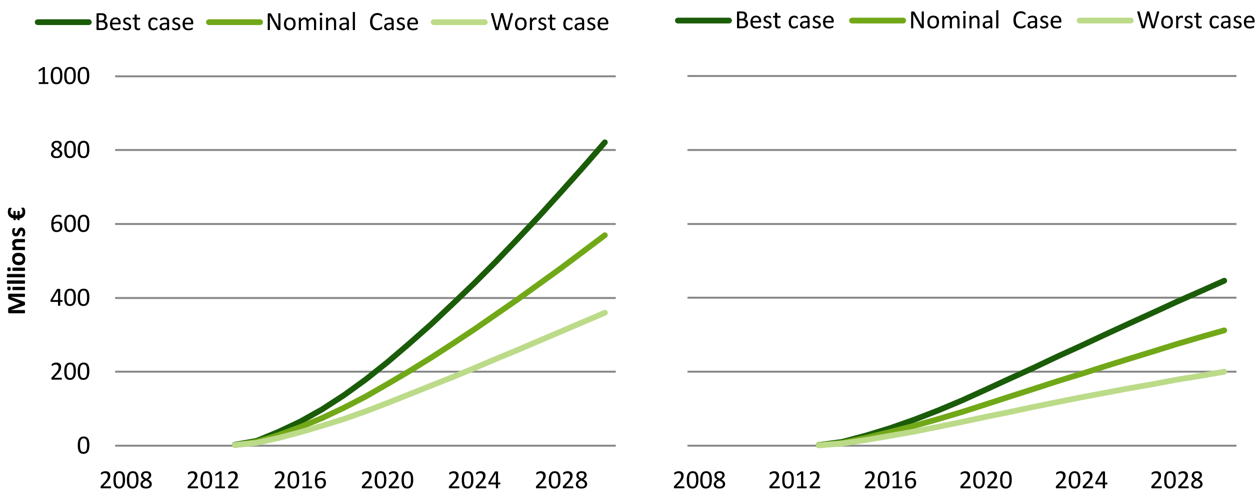

Figure 44: Uncertainties impact on Airspace users NPV

Figure 45 collects the cumulative probability of a specific DANUBE FAB NPV value for Airlines to materialize, reflecting the impact of the uncertainty variables to the overall variability by quantifying the risk associated to each NPV value. The nominal NPV value of 570 M€ is associated to a 50% probability value, resulting from the fact that the distribution of probability of the input variables is generally centred and symmetric with respect to the base value. This indicates that the probability for a lower than nominal NPV to materialize is practically equivalent to the probability for a higher than nominal one.

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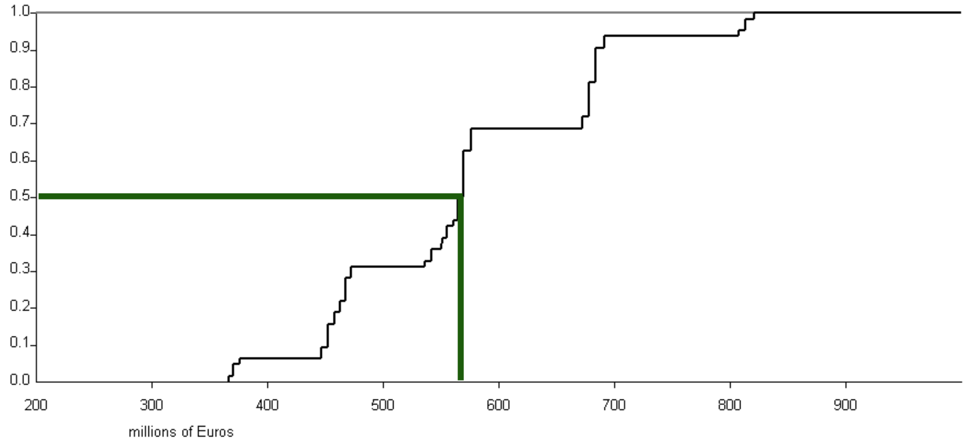

Figure 45: Airlines NPV Cumulative probability

Impact on main Airlines

This section is devoted to the quantitative analysis of the distribution of external benefits generated by the establishment of DANUBE FAB on its principal Airspace Users. Historical traffic data provided by ROMATSA and BULATSA were used to determine the Airlines operating during the three representative days of traffic in 2010 (01/01/2010, 02/07/2010, and 19/10/2010). For each of these days, a weight has been applied according to the traffic model explained in Section 4.2.4.

¡Error! No se encuentra el origen de la referencia. lists the main Airlines in terms of Service Units roduced within the DANUBE FAB Airspace according to the traffic model. They cover the 45% of the total Service Units generated and almost the 42% of the IFR traffic controlled.

Airline	Service Units	Flights
Emirates Airline	8,9%	3,9%
Turkish Airlines	7,8%	9,0%
Lufthansa	4,7%	4,4%
British Airways	3,5%	2,4%
Qatar Airways	3,5%	1,7%
Etihad Airways	3,3%	1,7%
Pegasus Airlines	3,2%	4,1%
SunExpress	3,1%	4,1%
Air France	2,4%	1,6%
Sky Airlines	2,2%	3,12%
Tarom	2,2%	5,2%
Bulgaria Air	0,3%	0,97%

Table 59: Share of traffic by the main Airlines operating in DANUBE FAB

Emirates is the first user in terms of Service Units generated, but only the sixth in terms of number of flights, due to the fact that in general it operates larger Aircraft for longer distances. This is why the Service Units in addition to the number of flights have been considered as a proxy to calculate the impact on Airlines; savings in fact will be in general higher when the FAB is used for longer distances and with aircraft imposing higher direct operating costs.

To calculate the savings for each year and for each Airline, the total yearly savings of the FAB were multiplied by the Airline share of Service Units within the overall traffic model.

The share of traffic and Service Units by operating Airlines has been considered constant over the study time horizon, since there were no specific elements to suggest a different assumption.

The graph in Figure 46 shows the annual discounted savings due to the FAB implementation for each airline and for the years 2015, 2020 and 2030:

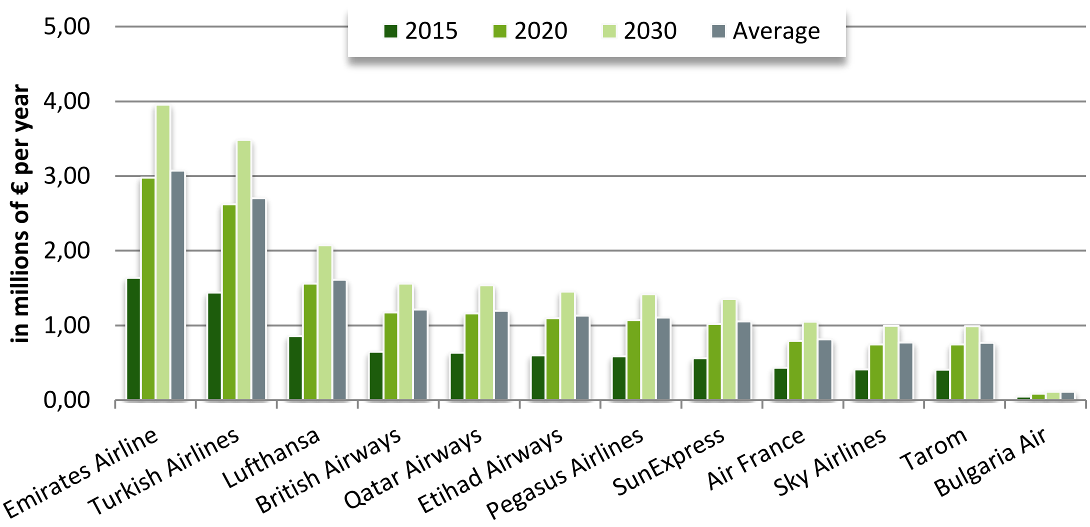

Figure 46: Total annual discounted savings per Airline

According to the assumptions made, Emirates will save approximately 1,6 M€ in 2015, 2,9 M€ in 2020 and 4,0 M€ in 2030 as a result of the enhanced operational efficiency enabled by the FAB operational improvements.

Once established the yearly savings for each airline, this value was divided by the product between the percentage of flights operated by the same Airline and the total Impacted Annual Traffic Forecast.

For example, Emirates has a share of 3,9% of the total IFR flights controlled, while the Impacted Annual Traffic Forecast is 838.000 in 2015, so the savings per flight are 48,0 € per flight (i.e. 1,6 M€ divided by 3.9% of the 808.000 impacted flights).

The graph in Figure 47 shows the savings per flight for each year and for each Airline:

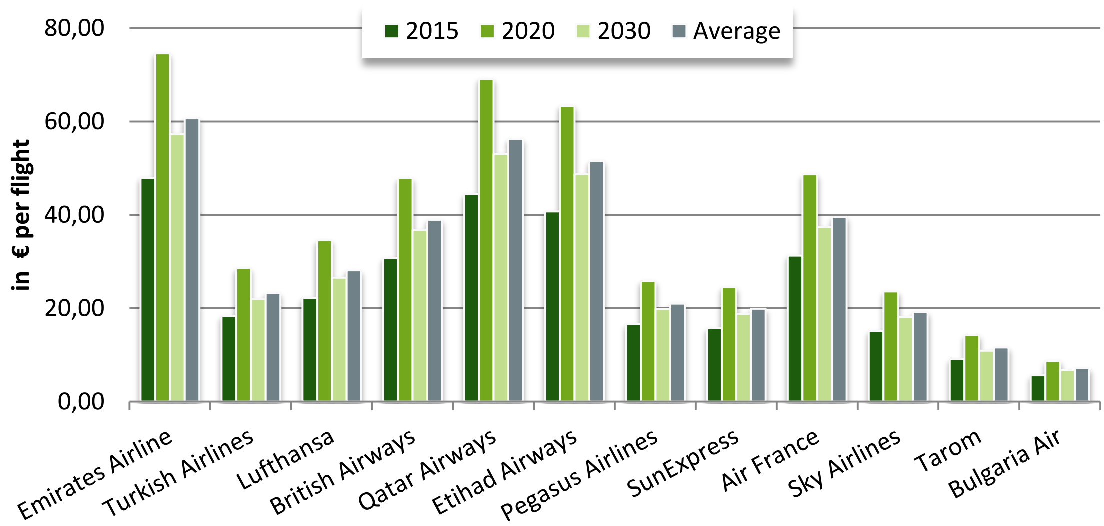

Figure 47: Total annual discounted savings per flight

5.2.4 Impact of ANSPs savings on Airspace users

Due to the positive cash flow for ANSPs and to the fact that their internal benefits are partly transferred onto Airspace Users due to the mechanism for calculation of Unit Rates based on determined costs (EC Reg.), a positive impact is expected to verify on Airspace Users in addition to the one directly implied by external benefits. A specific contribution of the internal benefits to the reduction of the national Unit Rates has not been included in the analysis, due to the risk of double counting and to the uncertainty around the exact phasing of benefits.

However the impact of ANSP internal benefits per Service Units as presented in Figure 48 (respectively per flight as presented in Figure 49) has been calculated separately by dividing the yearly projected ANSP cash flows by the number of forecast Service Units (respectively by the number of forecst IFR flights controlled).

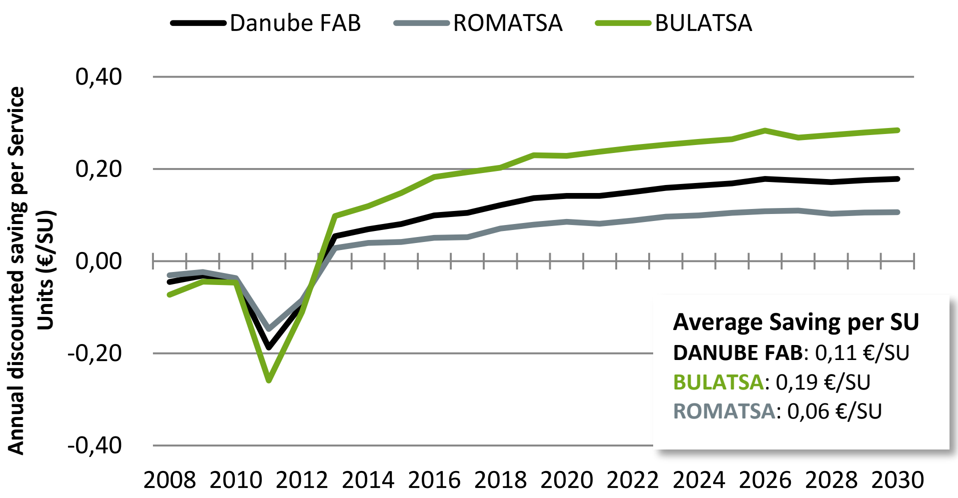

Figure 48: Annual ANSPs discounted cash flows per Service units

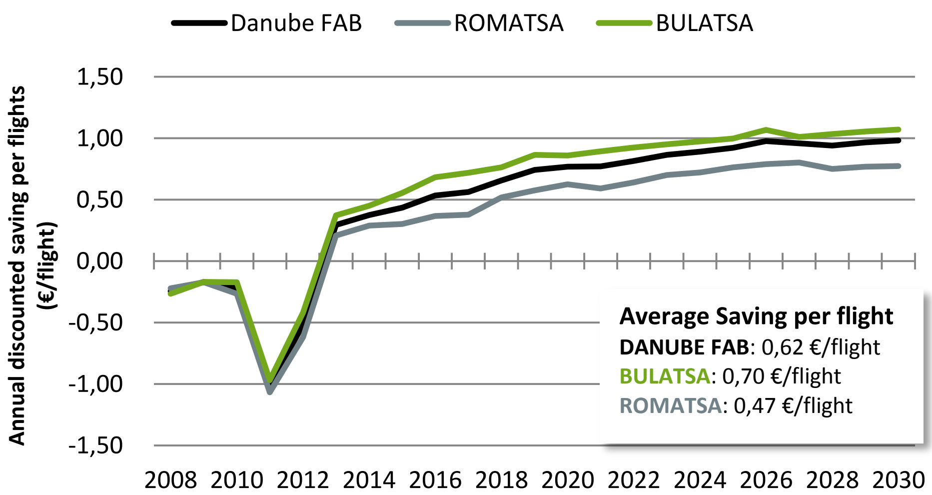

Figure 49: Annual ANSPs discounted cash flows per flight

6 Conclusions

The establishment of the DANUBE FAB implies two main types of impacts:

- The internal costs and benefits experienced by the two ANSPs operating within the scope of DANUBE FAB, i.e. ROMATSA and BULATSA.
- The external costs and benefits impacting external stakeholders as an effect of the establishment of DANUBE FAB.

The results of the CBA show a positive NPV for both stakeholder's categories considered. The inherent uncertainty in future data affects only the NPV value, but not the overall result of the CBA which continues to be positive.

For external stakeholders (Airlines), since no costs are attributable to FAB the benefits coincide with the start of FAB operations in early 2013. The operational improvements introduced within the scope of DANUBE FAB (route network modifications and Free Route Airspace enabled by a Common FAB operational Concept) will imply important cost savings for the Airlines thanks to the enhanced flight efficiency. Fuel savings represent the most important savings with a 64% share, followed by Operating Cost savings with 32% of the total and finally CO_2 savings that only represent 3% of the total.

The NPV for the Airlines as a whole in the base case is 570 M€ for the period 2008 to 2030. Notwithstanding the possible change to this value, according to the uncertainty related with future values of fuel cost, of CO2 value on the ETS market or traffic evolution, the worst case scenario assuming all the uncertainties materialize with their worst impact indicates a NPV of 360 millions of Euros.

For the ANSPs, the pre-implementation investments and additional training costs attributable to the FAB extend the pay-back period considerably and hence the break-even point is reached by 2017. Benefits balancing pre-implementation and implementation activities will result from a more rational use and structure of the airspace leading to ATCOs being able to handle more flights. This in turn will result in a reduced number of new ATCOs needed to be recruited and trained with respect to the baseline scenario, translated into 15,4 M€ savings in 2030 with respect to the baseline scenario. Additionally, a number of commonalities in the training system will afford clear opportunities to cooperate to maximise the success rates of selection and training as well as improving cost effectiveness, although results show that benefits will be low in this area. With regard to the management of SQSE, cost avoidance benefits will arise from the sharing of experience and effort for work execution (e.g. preparation of documentation, manuals, amendments, procedures analysis, safety assessments, etc) between SQSE from different ANSPs. Results show that SQSE management harmonization will contribute in 4,3M€ of savings in 2030. Rationalization of CNS infrastructure, optimally deployed within the context of DANUBE FAB operations will imply cost savings of 3,8 M€ in 2030. Common procurement policies will see benefits related to the common procurement of communication services, implying cost savings of 0,42 M€ in 2030

The NPV for ANSPs as a whole in the base case is 21 M€ for the period 2008 to 2030. However, possible changes on this value are related to the uncertainty of future values of the different inputs having a role in the CBA, being the discount rate and the ATCOs cost avoidance uncertainty the parameters impacting the most the final NPV. The worst case scenario in the event all uncertainties occur with their worst impact indicate a NPV of 18,1 M€ in 2030 with a 4% discount rate.

7 References

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8 ANNEXES

8.1 Reference Information

The rest of this section presents extract from the main applicable references (*in italic*) as well as an explanation of the compliance of the DANUBE FAB CBA & BC with them.

8.1.1 Performance Scheme: Initial EU-wide Targets Proposals

As an example of what may reasonably be expected on short and mid-term, for RP1 (2012-2014), the Eurocontrol PRC [13] considers that the establishment of FABs will lead to a number of 'quick wins' such as:

- *common procurement,*
- *integrated training*
- *airspace design leading to improvements in flight-efficiency and capacity*

Institutional and business restructuring may take longer to achieve significant cost reductions.

All the costs and benefits stemming from common procurement, integrated training and optimized airspace design have been separately accounted for in the CBA, in addition to other benefit opportunities identified for the DANUBE FAB. These may become effective in the short-term scenario. ON the other hand the partial integration model retained for the short-term implementation does not involve any major institutional and business restructuring to the Romanian and Bulgarian stakeholders concerned, as recognized by the Performance Scheme.

8.1.2 FAB Guidance Material [10]

"A CBA may be performed in a basic, 'light' approach at an early stage of a project, when costs and benefits are estimated in terms of data ranges and the involvement of stakeholders is limited; or in a more enhanced, 'heavier' approach, when data inputs on costs and benefits are validated with strong involvement of the impacted stakeholders. A CBA is mainly recommended when the majority of costs and benefits of a project are quantifiable. It is a useful technique for comparison and selection of the best option out of several different projects (e.g. between different possibilities/ scenarios of partnership arrangements in a FAB with respect to achieving a specific objective)."

The current Detailed Design and Pre-implementation Phase of the DANUBE FAB project is considered advanced enough to produce reliable quantifications of costs and benefits, based on a mature concept of Operations, common functions and technical architecture defined for the FAB. Since the main options for FAB implementation have been already analysed by the partner States and main agreements have been achieved, the main possibilities included in the CBA for the short-term period are just the FAB and No FAB options. In the mid-to-long term (i.e. 2015 and beyond), due to higher uncertainty and margins from decision making, several options have been included in the analysis concerning the realization of common functions, where these were foreseen feasible by experts.

"Cost-benefit analysis (CBA) is a quantitative method that uses the discounted cash flow analysis. It is a financial appraisal technique used across all industries and particularly in the production of CBAs for ATM projects. Discounted cash flow analysis takes account of the time value of money and is used to compare costs and benefits which occur at different points in time. An amount of money received today is normally considered to be of higher value than the same amount of money in the future considering the use which may be made of those funds in the intervening period and the greater uncertainty associated with future transactions. CBA measures the overall value added, by calculating a financial result (Net Present Value). A positive Net Present Value demonstrates that a given project would bring additional value."

The present CBA is based on discounted cash flow analysis and measures the overall added value of the DANUBE FAB through the Net Present Value

"A CBA not only includes an assessment of the known information, but also an appreciation of the risks and uncertainties and the degree of confidence which may be placed on the results."

Uncertainties related to future values of costs and benefits have been estimated according to projection of historical data, scenarios of change in the European ATM and expert judgment. Sensitivity of NPV to uncertainties is expressed through Tornado Diagrams. Risk analysis is included both in the CBA in a quantitative manner (Cumulative probability Curve) and in the BC in a more descriptive and qualitative one.

8.1.2.1 FAB Stakeholders concerned

The CBA should provide a consolidated view of the impact of the FAB on all relevant stakeholders, including, the ANSPs (civil and military), civil and military airspace users (general aviation, aerial work, commercial air transport, state aircraft), airports, NSAs/ regulators. The FAB States may allocate specific responsibilities as regards the conduct of the CBA and provide for consultation of the relevant stakeholders by means of an act pursuant to the MA or within the FAB management mechanisms.

While the consolidated CBA position should be of prime importance for demonstrating that a FAB is justified by its overall added value, this does not exclude building separate CBAs for groups of relevant stakeholders, to understand and demonstrate the impact on a particular stakeholder group.

ANSPs and commercial airspace users have been explicitly taken into account by the CBA. Other categories of airspace users have been taken into account in the BC, since it has been identified that they will experience qualitative more than quantitative benefits, without suffering any costs from FAB implementation.

8.1.2.2 Necessary and/or optional partnership arrangements, estimated feasibility and value-added

The necessary partnership arrangements for the production of the CBA for a FAB are those ensuring that the CBA is based on accurate information/data provided/ validated by the stakeholders concerned and on the validated/ agreed FAB scenario. Consultation of those stakeholders should therefore be ensured. The CBA needs to translate into financial terms all relevant FAB requirements, conditions and arrangements that imply changes from the pre-FAB operations to the FAB operations. Some examples include: changes in the management of human resources, changes in the ATM/CNS technical infrastructure, changes in the structure of service provision, changes in the application of the principles and rules for charging etc.

As regards its management, a CBA is a form of financial analysis and can be lead as agreed by the FAB partners, by any competent internal FAB representative or body which is assigned this responsibility, or by an external consultancy having expertise in conducting CBA studies in the area of ATM/ANS.

CBA has been based on FAB past and parallel FAB assessment, involving different Working Groups experts to provide range estimations whenever these were not achievable through simulation results or historical data projection. Public procurement procedures have been followed to select the contractor for execution of the CBA and BC for the DANUBE FAB. The procedure awarded the contract to the Advanced Logistics Group, consultancy firm of the Indra Group specialized in consultancy services for change management to public and private stakeholders in ATM.

8.1.2.3 Impact or implications of arrangements, e.g. on FAB operations, stakeholders, performance, flexibility etc

The arrangements for producing the CBA do not have any impact by themselves on the FAB operations, stakeholders etc. The only tangible impact lies in the cost of the CBA. The estimated effort depends on whether only an overall CBA is conducted or if this work also includes additional CBAs for individual or groups of stakeholders.

The cost for the contract “Consultancy services for the elaboration of Cost Benefit Analysis and the Business Case for the DANUBE FAB”, have been accounted as pre-implementation costs.

It should also be noted that the results/ conclusions of a CBA which is based on inaccurate data or assumptions as regards the stakeholders or the foreseen changes to FAB arrangements and operations may have a negative impact on the ensuing operations, stakeholders, performance etc.

The CBA relies on the most updated information and data resulting from the parallel activities under the umbrella of the DANUBE FAB projects. All external references have been used according to their latest available edition. Additional projections and Experts’ estimations have been formalized, based on multiple sources and according to intervals rather than point estimates, in order to take into account uncertainty in future scenarios

8.1.2.4 Dependencies and relation to other requirements or conditions

The CBA in support of establishing or modifying a FAB should evaluate the financial impact of all the effects, in terms of potential costs or benefits, resulting or derived from the establishment of the FAB. Thus, the CBA normally requires that the majority of the FAB-relevant requirements and conditions that are implemented by means of various FAB arrangements are translated into financial terms when building the CBA.

The CBA draws inputs from – and consequently interacts with – the operational requirements on which a FAB is based and the underlying processes by which FABs address and fulfil several of Article 9a(2) requirements, such as those for:

1. *optimum airspace utilisation and consistency with the European route network (section 7.4.3/ checklist item 4.3),*
2. *the smooth and flexible transfer of responsibility for ATC (section 7.4.6/ check-list item 4.6),*
3. *the compatibility of airspace configurations and optimisation of airspace structures (7.4.7/ 4.7),*
4. *setting national or FAB level performance plans and targets consistent with the EU-wide performance targets (section 7.4.10/ check-list item 4.10); etc.*

The CBA has been funded on the results obtained and documentation produced during the current DANUBE FAB Phase. These include the list of DANUBE FAB common functions [5], an analysis of technical infrastructure [12], a catalogue of Airspace and Network improvements [11], a FAB Concept of Operations [7]. In addition a number of National publications have been used to establish the baseline scenario ([6], [8], [9]).

8.1.2.5 Guidelines in relation to the information requirements of the FAB-IR

With respect to the information requirements as per §4 of Part Two of the Annex to the FAB-IR (ref. [15]), as a minimum it is expected that Member States concerned in a FAB provide statements confirming that:

a. *The CBA was conducted according to industry standard practice, using among others discounted cash flow analysis;*

The discounted cash flow analysis has been employed to produce the CBA, according to industry practice

b. *The CBA provides a consolidated view of the impact of the establishment or modification of the FAB on the civil and military airspace users;*

The CBA provides the consolidated view as well as the individual impacts for BULATSA, ROMATSA and Commercial Airlines. The impact on other stakeholders (Militaries, Airports, NSAs, Regulators, general aviation) will be qualitatively analysed in the Business Case.

c. *The CBA demonstrates an overall positive financial result (Net Present Value and/or Internal Rate of Return) for the establishment or modification of the FAB;*

The overall financial result is presented as NPV

d. *The FAB contributes to a reduction of the aviation environmental impact;*

The positive impact of DANUBE FAB operations on the environment has been already assessed in [5]

e. *The values for costs and benefits, their sources and the assumptions made to develop the cost-benefit analysis were documented;*

All the input data are documented along the document and in particular in Annex A

f. *The main stakeholders were consulted and provided feedback on the costs and benefit estimates which are applicable to their operations.*

A preliminary meeting has been organized between ALG and experts from both ROMATSA and BULATSA on the 28th – 29th February 2012. During this meeting the benefit initiatives were discussed in depth, involving experts from all Working Groups, according to their area of expertise. A Workshop on April 19th has been organized with other relevant stakeholders (IATA, NSAs) to present the results and obtain their feedback. Based on the results of this workshop, a final version of the CBA and BC have been produced in early May 2012.

8.1.2.6 Recommended actions and supporting evidences

As per item 4.5 of the FAB guidance check-list , the following constitutes a checklist for compliance:

- ✓ *The FAB States must build a consolidated CBA which includes the effects on all impacted stakeholders. A consolidated CBA calculates just one result which is the overall value from the establishment of that FAB. It demonstrates that it is worthwhile undertaking, considering all stakeholders together; however it does not demonstrate the value of establishing a FAB from the* *view of any one particular stakeholder. This however, does not limit or prevent the development of separate CBAs for stakeholder groups, in order to better understand or emphasize the impact on a particular stakeholder group.*

- ✓ *The CBA must demonstrate, inter-alia, that there is optimised use of technical and human resources in the FAB vs. the pre-FAB situation. All costs and benefits resulting from FAB establishment should be included in the CBA model; this should also include optimal use of human and technical resources.*
- ✓ *Use discounted cash flow analysis, a technique used within financial appraisal across all industries and, in particular, in the production of cost-benefit analyses of ATM projects. It takes into account the time value of money and is used to compare costs and benefits at different points in time (see more in 5.3.3).*
- ✓ *The FAB partners and stakeholders should be transparent on their assumptions and expectations. A CBA is based upon projections of future outcomes and in this area there are no right or wrong answers. However, some projections are more credible than others. Transparency and documenting the assumptions on costs and benefits improve the credibility of a CBA in the eyes of the stakeholders, by allowing them to review the assumptions and share their views of the future. Transparency also increases the quality of a CBA by decreasing the chances of error and bias as well as allowing more refined versions of the CBA model to be built. CBA modelling is an iterative process; more mature versions of the CBA will replace the earlier versions. In order to increase transparency to the extent possible, it is recommended to include in the CBA report the following:*
    - *All costs and benefits, the sources of these values and all assumptions made with regards to costs and benefits;*
    - *The discount rate used;*
    - *The time horizon;*
    - *The statement of cash flows;*
    - *The financial results (including Net Present Value and/or Internal Rate of Return);*
    - *A description of how uncertainty in the values of inputs was dealt with;*
    - *A discussion of the non-financial benefits (and costs if applicable) due to FAB establishment, for example reduced impact on environment.*
- ✓ *Consult the main stakeholders to validate data inputs to the CBA (costs and benefits). Stakeholders are in the best position to validate the assumptions made while building the CBA. Stakeholders can normally provide better quality data than data available from other sources and thus their data should enable the CBA model to become a more realistic picture of the “overall added value” of a FAB.*

In practice there may be considerable uncertainty about the future values of costs and benefits; validated data on costs and benefits may be difficult to obtain; and data may exist only in the form of assumptions or expert judgement. Particularly in cases where high quality data cannot be available, data may be provided in the form of a data range (such as minimum value, most likely value, maximum value) so that the effects of possible variations in costs and benefits may be taken into account by means of a sensitivity analysis.

- ✓ *To maximize the overall value added, the following points will improve the quality of the CBA:*
    - ✓ *Suitably qualified personnel (with economic/financial educational background and/or work experience) should conduct the CBA. The CBA model should be reviewed by qualified personnel who were not involved in the model production.*
    - ✓ *Separate CBAs should be built for the main stakeholders. Although, the consolidated view is of a primary importance, separate CBAs will show the impact of a FAB establishment on a particular stakeholder or group of stakeholders. This information may be valuable to the decision-makers.*
    - ✓ *Consider alternative scenarios with regards to FAB establishment. Alternative scenarios allow the decision makers to choose among various options with regards to FAB establishment. In this way the “overall value added” of a FAB can be maximized.*
    - ✓ *Consult stakeholders through interactive workshops. The typical workshop takes two days. There can be more than one workshop per CBA, however the first one is the most*

important. By the end of this workshop a first version of the model is built. All benefits and costs mechanisms are understood and agreed, so that benefits and costs are mapped into the € value. Inputs are refined, sources to further refine the inputs are established and actions on who will supply the information are determined.

- ✓ *Deal with uncertainty in the data inputs through the use of data ranges. Derive financial results (Net Present Value, Internal Rate of Return) in form of a data range to understand the risk profile of the project (FAB establishment). In practice there may be considerable uncertainty about the future values of costs and benefits, validated data on costs and benefits may be difficult to obtain and the data may exist only in the form of assumptions or expert judgement. Particularly in cases where high quality data cannot be obtained, data should be provided in the form of a data range (such as minimum value, most likely value, maximum value) so that the effects of the possible variations in costs and benefits may be taken into account by means of a sensitivity analysis.*
- ✓ *Conduct a sensitivity analysis to see how inputs of a CBA (costs and benefits) impact the results. Through sensitivity analysis of the model inputs, it becomes clear which inputs have the biggest impact on the result, so that further effort can be prioritised.*

8.2 Equations and analytical derivations

8.2.1 Traffic model weight coefficients

In order to derive annual figures from the daily data of [4], representativeness of each sample day is captured through the use of weight coefficients: A, B and C. A daily traffic distribution over the entire year for 2010 is obtained from STATFOR Interactive Dashboard (Figure 50) and the arithmetic mean is applied over the traffic distribution indicating an average value of 2665 flights/day. This value is then used to compute a balanced weighted average according to the set of equations below and hence to calculate the relative weights applicable to the three days of traffic analysed:

$$\begin{cases} 1293A + 2708B + 3798C = 2665 \\ A + B + C = 1 \\ \dfrac{\sum_{i=0}^{N}|3798 - x_i|}{\sum_{i=0}^{N}|1293 - x_i|} = \dfrac{C}{A} \end{cases}$$

Where, 1293 and 3798 are the number of flights controlled in the low and high representative days (respectively 01/01/2010 and 02/07/2010), as reported in Table 60. N is the annual STATFOR sample size (N=365-5=360). The five days are subtracted to account for the outliers present as a result of Eyjafjallajökull volcano traffic disruptions. Solving for A, B and C yields A=0,0262, B=0,9531 and C=0,0207. The first and second equations impose the conservation of the average value, while the third one implies that the ratio of the distances between high and low traffic days and the rest of the days can be expressed as the ratio between their correspondent weight coefficients.

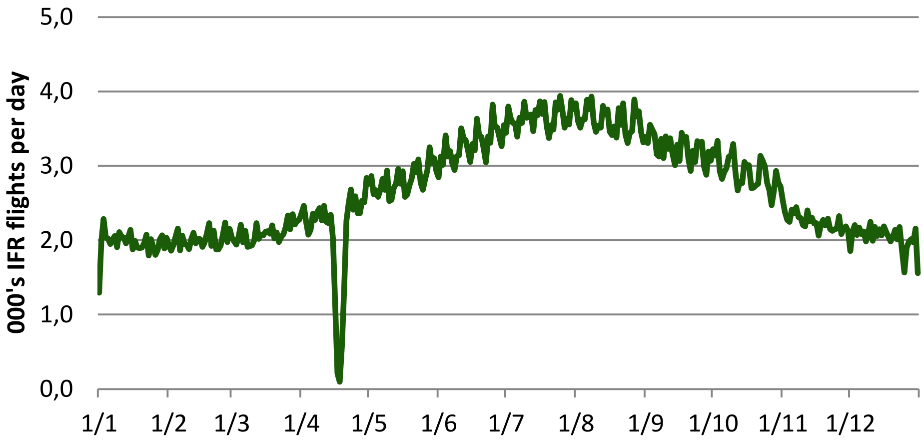


Figure 50: DANUBE FAB air traffic data (2010)

Date	Type of day	Total daily flights in DANUBE FAB	Weight coefficient
1/1/2010	Low traffic day	1293	A=0,0262
19/10/2010	Average day	2708	B=0,9531
2/7/2010	Peak day	3798	C=0,0207

Table 60: Traffic data used in the analysis

8.2.2 Impacted Traffic (ITF) time series calculations

Once weighted coefficients are calculated, annual impacted flight figures for the three scenarios (i.e., 2015, 2020 and 2030) are obtained by using the above weighting coefficients as follows,

$$ITF_{xxyy} = (A \cdot ITF_{1/1/xxyy} + B \cdot ITF_{19/1/xxyy} + C \cdot ITF_{2/7/xxyy}) \cdot 365$$

Where, $ITF_{,xxyy}$ stands for the impacted traffic values for each Scenario year xxyy and $ITF_{i/j/xxyy}$ stands for daily impacted traffic estimates for each representative day (day i, month j) and Scenario year (xxyy), collected in Table 61.

Representative day	Scenario 2015	Scenario 2020	Scenario 2030
1/1/2010	1094	1252	2138
19/10/2010	2386	2797	4841
2/7/2010	3556	4088	6795

Table 61: Impacted Traffic data (ITF) for the three representative days in the three years [4]

ITF (t) for the entire CBA timeframe is then obtained through linear interpolation between ITF2015, ITF2020 and ITF2030. Note that impacted traffic values before 2013 were considered null even if some modifications in the route network were introduced before, as FAB operational improvements. However to maintain consistency with the timing elements of the models, the implementation phase and the related operational improvements are considered to be first introduced in December 2012 . ITF (t) is plotted in Figure 52 under the terminology ITFb(t) It is assumed that seasonality remains constant for the entire DANUBE FAB time frame, i.e., annual representative days for 2015, 2020 and 2030 remain the same as in 2010 and their impact on the weighted average is unchanged.

Figure 51 shows the ratio of impacted-to-total FAB traffic, calculated as:

$$Ratio = \frac{ITF(t)}{Overall\ traffic\ (t)};\ 2012 < t < 2031$$

It is observed that the ratio increases from 2012 to 2015, when a first FAB Route network structure is established. The 2015 Route network considers proposals from the Danube route network catalogue and Route Network Development Sub Group (RNDSG). This first set of improvements introduced between 2012 and 2015 is considered to be gradual. From 2015 to 2020 the ratio between total and impacted traffic slightly decreases until 2020, when the introduction of a Free Route Airspace (FRA) on a 24-hours basis, leads to an increase in the ratio of impacted flights.

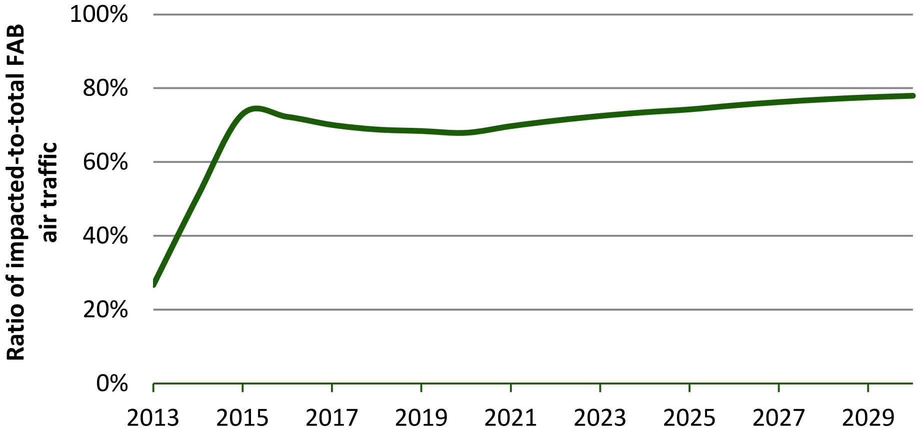


Figure 51: Ratio of impacted-to-total FAB air traffic

8.2.3 Traffic model: Traffic uncertainty calculation

The uncertainty is defined as a range around the base ITF (ITF_b) , derived by multiplying ITF_b by Δh for obtaining the High ITF (ITF_h) and by Δl for obtaining the Low ITF (ITF_l). Note that the three scenarios of total FAB traffic follow approximately linear progressions in time. Therefore, unique uncertainty ranges for the overall time series would suffice to define the different scenarios.

Nevertheless, this description refers to total number of flights rather than impacted flights, the latter being the actual ones used for the different benefits computation. Therefore, the time series of impacted flights need to be split into three different linear segments: 2012 to 2015, 2015 to 2020 and another one from 2020 to 2030, following the introduction of Free Route Airspace. Hence Δh and Δl were calculated for 2015, 2020 and 2030 to account for the different linear segments which define the impacted flights time series. Based on the data represented in Figure 13, Δh and Δl are calculated as

$$\Delta h\Big|_y = \frac{AT\Big|_{y,high} - AT\Big|_{y,base}}{AT\Big|_{y,base}}$$

$$\Delta l\Big|_y = \frac{AT\Big|_{y,base} - AT\Big|_{y,low}}{AT\Big|_{y,base}}$$

Where,
y - represents the year of computation, i.e., 2015, 2020 or 2030.
AT - represents the annual traffic for each year y.

Results from the above equations are summarized in Table 62, repeated here for convenience.

	Multiplying factor 2015	Multiplying factor 2020	Multiplying factor 2030
High(Δh)	1,05	1,13	1,15
Base	1	1	1
Low(Δl)	0,96	0,91	0,82

Table 62: Uncertainty traffic multiplying factors for 2015, 2020 and 2030

By applying the above multiplying factors to the Impacted Flights time series ITF(t) derived in section 8.2.1, high ($ITF_h(t)$), base($ITF_b(t)$) and low ($ITF_l(t)$) figures are obtained and plotted in Figure 52 repeated here for convenience from STATFOR data.

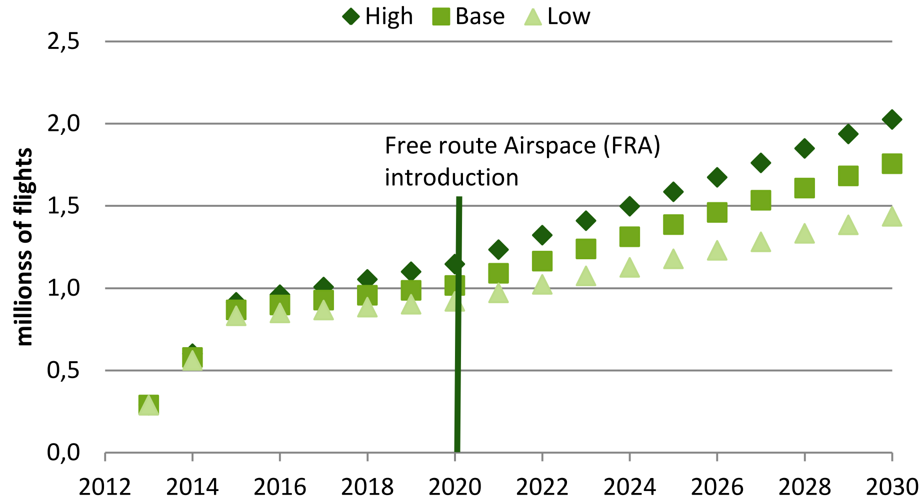


Figure 52: Impacted Annual Traffic Forecast (ITF)

8.2.4 Flight efficiency time series computation

By using the weight coefficients (A, B and C) derived in section 8.2.1 based on traffic figures, annual figures for Time savings, (TSF(t)), Fuel savings (FSF(t)) and CO2 savings COSF (t) are derived as follows from flight efficiency improvements data collected in Table 63.

$$TSF_{xxyy} = (A \cdot TSF_{1/1/xxyy} + B \cdot TSF_{19/1/xxyy} + C \cdot TSF_{2/7/xxyy}) \cdot 365$$

$$FSF_{xxyy} = (A \cdot FSF_{1/1/xxyy} + B \cdot FSF_{19/1/xxyy} + C \cdot FSF_{2/7/xxyy}) \cdot 365$$

$$COSF_{xxyy} = (A \cdot COSF_{1/1/xxyy} + B \cdot COSF_{19/1/xxyy} + C \cdot COSF_{2/7/xxyy}) \cdot 365$$

Where, the subscripts *xxyy* stand for each Scenario year relative to the impacted traffic values.

Savings	2015			2020			2030		
Characteristic days	1-1 Low	19-10 base	2-7 High	1-1 Low	19-10 base	2-7 High	1-1 Low	19-10 base	2-7 High
Weighting coefficient	0,0262	0,9531	0,0207	0,0262	0,9531	0,0207	0,0262	0,9531	0,0207
Impacted flights	1094	3556	2386	1252	4088	2797	2138	6795	4841
Daily time savings (min)	547	2292	1.289	1102	5070	3022	1918	8959	5566
Time savings per flight (min/flight)		**0,541**			**1,078**			**1,146**	
Daily Fuel savings (Kg)	34533	115064	61384	63421	224771	124577	105295	390069	219097
Fuel savings per flight(kg/flight)		**26,017**			**46,916**			**45,615**	
Daily CO_2 savings (Kg)	108434	361294	192740	199147	705794	391185	330639	1224834	697979
CO_2 savings per flight(Kg/flight)		**81,691**			**141,041**			**145,202**	

Table 63: Time, fuel and CO2 savings for three characteristic days in three Scenario years [4]

Time dependant functions for each saving reported in the table above are obtained for the entire DANUBE FAB time frame through linear interpolation between 2015, 2020 and 2030. Note that 2012 flight efficiency savings values were considered null, as FAB operations have not officially started, even if some FAB-related improvement has been already introduced.

Results are plotted in section 4.2.5. The fundamental underlying assumption is that seasonality remains constant for the entire DANUBE FAB time frame, i.e., the three annual representative days for 2015, 2020 and 2030 remain the same as in 2010 and their impact on the weighted average is unchanged.

8.2.5 DANUBE FAB traffic mix computation

The average traffic mix for 2010 has been calculated based on the mix of aircraft types observed during the three representative days specified in [4] weighted by the specific coefficients derived in section 8.2.1 as follows

$$[number\ A/C]_n = A \cdot [number\ A/C]_{n,1/1/10} + B \cdot [number\ A/C]_{n,19/10/10} + C \cdot [number\ A/C]_{n,2/7/10}$$

Where,
n - refers to each aircraft type overflying the FAB airspace as per 2010.
A, B, C – are the weights calculated in the traffic model
$[\text{number A/C}]_{n,x/y/zz}$ – indicates the number of aircraft of type 'n' observed in the traffic sample relative to the day x/y/zz.

A ratio per model is derived as,

$$ratio = \frac{[number\ a/c]_n}{\sum_{n=1}^{N}[number\ a/c]_n}$$

Where,
n - refers to each aircraft type overflying the FAB airspace as per 2010.
N - refers to the total number or aircraft type.

Figure 53 shows the distribution of Aircraft types in the overall DANUBE FAB traffic, including aircraft representativeness down to 2% of the total FAB traffic. Aircraft types are indicated by their ICAO code.

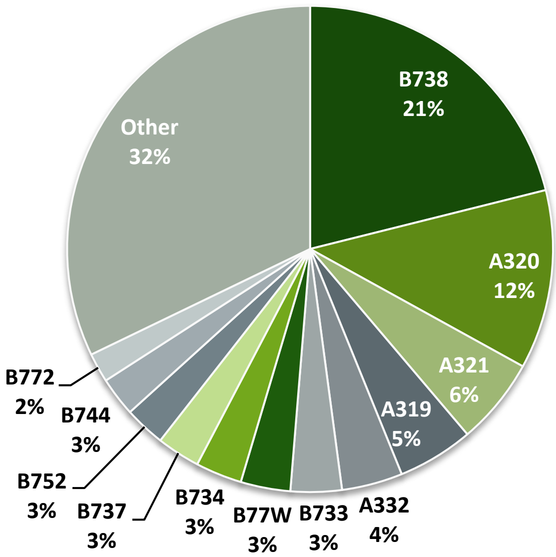


Figure 53: Aircraft type distribution overflying DANUBE FAB airspace (2010, ICAO aircraft codes)

The following Table gives the ICAO Aircraft codes given in the Figure 53. The category "Other" in the figure counts 115 types of aircraft.

ICAO code	a/c type
B738	Boeing 737-800
A320	Airbus 320
A321	Airbus 321
A319	Airbus 219
A332	Airbus 330-200
B734	Boeing 737-400
B733	Boeing 737-300
B77W	Boeing 777-300 ER
B734	Boeing 737-400
B737	Boeing 737-700
B752	Boeing 757-200
B744	Boeing 747-400
B772	Boeing 777-200

Table 64: ICAO Aircraft codes

8.2.6 Initial Operating Cost (IOCT) cost computation

The initial operating cost is computed by considering maintenance and flight crew costs (cockpit and cabin, without allowances) for each aircraft type collected in Table 65. Data were retrieved from an internal database maintained by an European Aircraft manufacturer, providing the necessary breakdown of costs per type of aircraft and sufficiently disclosed to extract only maintenance and crew. Another source of data considered was the EUROCONTROL standard inputs [1], but after consultation with its authors it was considered more outdated and less detailed than the first one, hence not used in the analysis..

Model	SAAB340	ATR 42	ATR 72	ERJ 145	CRJ 200	EMB 170	EMB 190	F100	732	735
Maintenance	384,6	428,2	475,0	488,2	498,2	586,6	633,5	807,1	859,2	641,0
Cockpit Crew without allowances	162,5	162,2	173,8	170,9	170,9	176,0	176,0	189,0	188,9	200,0
Cabin Crew w/o allowances	25,2	27,0	43,2	31,8	31,8	45,5	51,2	51,2	66,7	66,7
Impacted DOC, EUR/FH (2012)	**461**	**498**	**558**	**557**	**565**	**652**	**694**	**844**	**899**	**732**

Model	A318	M87	737	M83	752	733	A319	A320	738	A330-200
Maintenance	565,5	718,0	623,9	710,6	881,6	665,0	600,3	622,0	643,8	731,7
Cockpit Crew without allowances	207,7	200,0	177,2	200,0	168,8	185,2	185,2	185,2	185,2	408,2
Cabin Crew w/o allowances	79,4	66,7	73,0	88,9	98,8	63,8	69,1	85,1	85,1	192,2
Impacted DOC, EUR/FH (2012)	**687**	**794**	**705**	**806**	**927**	**737**	**689**	**719**	**737**	**1074**

Table 65: Impacted direct Operating cost per aircraft type (2012 Euros).

A weighted average of the above costs was carried out according to the aircraft distribution calculated in section 8.2.1 and as per the formula below:

$$IOCT(2012) = \sum_{0}^{N} COST_n \cdot \frac{[number\ a/c]_n}{[number\ a/c]_{total}} = 811\ €/block\ hour$$

Where $COST_n$ indicates the Initial Impacted Direct Operating Costs per block hour and aircraft type (indicated by n) as specified in Table 65. For those aircraft models without operating costs data available, an equivalent model was chosen in order to compute the overall mean. Finally, an average value of IOCT= 802 Euros/flight hour was obtained accounting for maintenance and crew costs (without allowances).

8.2.7 Operating Cost Growth rate (OCG) computation

The growth rate of the initial impacted operating cost calculated in Annex 8.2.6 was derived according to an uncertainty range.

According to data published by IATA [30], the average growth rate in nominal terms for the period 2003-2010 is 0,9% which would give around -0,2% in real terms. However this includes all the non-fuel direct operating costs and is measured per Available Seat Kilometre. Hence considering that in the same period the unit cost per kilometre decreased by 2% [31] in Europe in terms of en-route charges, and that this contribution is embedded in the IATA numbers but not to be included in this CBA as explained before, the lower bound for OCG has been set to 0%.
On the other hand, the upper band has been calculated taking into account inflation rate forecasts, as both maintenance and crew costs fluctuations depend on national inflation. In order to use a representative inflation indicator which captures the wide variety of airlines flying through the FAB, carriers have been given a inflation rate time series in accordance to their nationality for which the International Monetary Fund (IMF) provides medium term economical forecasts.
Airline nationalities have been clustered into representative economical regions according to the IMF characterization, as shown in Table 66. Only 85% of airlines operating in the FAB have been classified by nationality, whilst to the remaining 15% have been assigned the same average inflation value obtained on the rest of Airlines. Given that IMF medium term forecasts provide inflation tendencies until 2017, a constant growth rate equivalent to the 2017 one has been considered beyond this year. This assumption is in line with the medium term tendency forecasted by IFM, as can be deduced from Figure 54. Finally a weighted average has been calculated taking into account the weight of each Airline on the overall DANUBE FAB Airline mix and final lower and upper bands for OCG have been calculated as summarized in Table 67. The base band is assumed to lie in the middle between the upper and lower ones.

Overall, by computing a weighted average to account for the weight of each airline on the overall DANUBE FAB airline mix, a final lower and upper bands for OCG are calculated as summarized in Table 67. The base band is assumed to lie in the middle between the upper and lower ones.

Airlines	Country	Country Group	2012 IR	2013 IR	2014 IR	2015 IR	2016 IR	2017 IR	2018-2030 IR
Tarom	Romania	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
SunExpress	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Pegasus Airline	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Sky Airlines	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Turkish Airline:	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Carpatair	Romania	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Blue Air	Romania	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Bulgaria Air	Bulgaria	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Free Bird Airlin	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Onur Air	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Atlasjet	Turkey	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Air Max	Bulgaria	Central and eastern Europe	6,2%	4,5%	3,9%	3,8%	3,8%	3,8%	3,8%
Belavia Belaru	Belarus	Commonwealth of independent states	7,1%	7,7%	7,2%	6,9%	6,6%	6,5%	6,5%
Aerosvit Airline	Ukraine	Commonwealth of independent states	7,1%	7,7%	7,2%	6,9%	6,6%	6,5%	6,5%
Aeroflot Russia	Russia	Commonwealth of independent states	7,1%	7,7%	7,2%	6,9%	6,6%	6,5%	6,5%
Air Moldova	Moldova	Commonwealth of independent states	7,1%	7,7%	7,2%	6,9%	6,6%	6,5%	6,5%
Air India Limite	India	Developing asia	5,0%	4,6%	4,0%	3,9%	3,6%	3,6%	3,6%
Pakistan Interr	Pakistan	Developing asia	5,0%	4,6%	4,0%	3,9%	3,6%	3,6%	3,6%
Niki	Austria	Euorpean union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Austrian Airlin	Austria	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Wizz Air	Hungary	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Malév	Hungary	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Transavia Holl	Netherlands	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
LOT Polish Airli	Poland	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Czech Airlines	Czech Republic	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
KLM Royal Dut	Netherlands	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Travel Service	Czech Republic	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Finnair	Finland	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Air Baltic	Latvia	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
FlyLAL Charter:	Lithuania	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Alitalia	Italy	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Mytravel Airwa	Denmark	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
TUIfly Nordic	Sweden	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Eurocypria Airl	Cyprus	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Novair	Sweden	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Olympic Airline	Greece	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
TNT Airways	Belgium	European union	2,3%	1,8%	1,9%	1,9%	1,9%	1,9%	1,9%
Lufthansa	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
British Airways	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Air France	France	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Air Berlin	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Thomas Cook A	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Condor Flugdie	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Hamburg Inter	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Thomsonfly	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
easyJet	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Germania	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Delta Air Lines	United States	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Star XL Germar	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
bmi	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Germanwings	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
World Airways	United States	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Omni Air Interr	United States	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Monarch Airlin	United Kingdor	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
FSH Luftfahrtur	Germany	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
United Parcel S	United States	G7	1,8%	1,6%	1,6%	1,6%	1,7%	1,8%	1,8%
Aerotransporte	Mexico	Latin america and caribeean	6,4%	5,8%	5,8%	5,6%	5,6%	5,6%	5,6%
Aeroexpreso In	Colombia	Latin america and caribeean	6,4%	5,8%	5,8%	5,6%	5,6%	5,6%	5,6%
Emirates Airlin	United Arab En	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Etihad Airways	United Arab En	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Qatar Airways	Qatar	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Corendon Airlii	Turkey	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Tuninter	Tunisia	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
AMC Airlines	Egypt	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Iran Air	Iran	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Gulf Air	Oman	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Middle East Air	Lebanon	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Saudi Arabian A	Saudi Arabia	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
KoralBlue Airlii	Egypt	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Lotus Air	Egypt	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
MNG Airlines	Turkey	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Royal Jordania	Jordan	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Egyptair	Egypt	Middle east and north africa	9,5%	8,7%	8,3%	7,5%	7,2%	6,9%	6,9%
Singapore Airli	Singapore	Newly industrialized asian economies	2,9%	2,7%	2,6%	2,6%	2,6%	2,6%	2,6%
Cathay Pacific	Hong Kong SAR	Newly industrialized asian economies	2,9%	2,7%	2,6%	2,6%	2,6%	2,6%	2,6%
El Al Israel Airli	Israel	Othe advanced economies	2,5%	2,5%	2,4%	2,4%	2,4%	2,4%	2,4%
Swissair	Switzerland	Other advanced economies	2,5%	2,5%	2,4%	2,4%	2,4%	2,4%	2,4%
Farnair Switzer	Switzerland	Other advanced economies	2,5%	2,5%	2,4%	2,4%	2,4%	2,4%	2,4%

Table 66: Inflation rate forecasts per airline type

units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
High scenario	FMI: European union (April 2012)						Extrapolation								
OCG (t)	4,88%	4,00%	3,71%	3,57%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%	3,53%
Impacted operating cost (EUR/BH)	811	850,8	884,8	917,6	950,4	983,9	1018,6	1054,5	1091,7	1130,2	1170,0	1211,2	1253,9	1298,1	1343,9
Base scenario							Extrapolation								
OCG(t)	2,44%	2,00%	1,85%	1,79%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%	1,76%
Impacted operating cost (EUR/BH)	811	831,0	847,6	863,3	878,7	894,2	910,0	926,0	942,4	959,0	975,9	993,1	1010,6	1028,4	1046,5
Low scenario	Flat rate assumed						Extrapolation								
OCG(t)	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Impacted operating cost (EUR/BH)	811	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2	811,2

Table 67: OCG(t). High, base and low scenarios

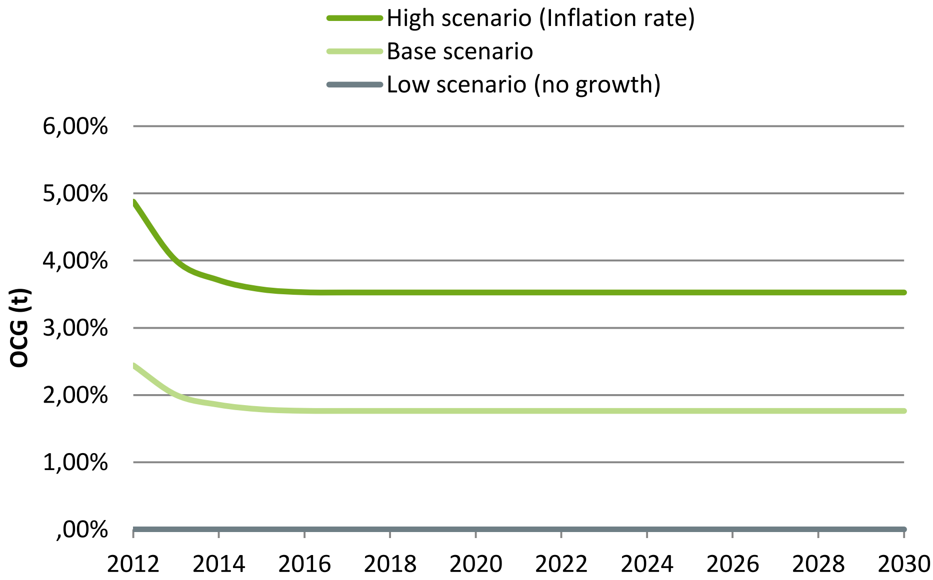


Figure 54: OCG(t). High, base and low scenarios.

8.2.8 Airspace design & management and common operational concept one-off implementation costs

The type B training costs time series has been calculated according to ROMATSA inflation rate as described below

$$CTB(t) = \sum_{t=t_0+1}^{T} CTB(t-1) \cdot INF_R(t)$$

Where

t_0 – 2013 is the reference year

T – 2030 is the final year considered by the CBA

INF_R – is the ROMATSA national inflation rate obtained from [6] for the period 2013-2015, and takes a constant value beyond 2015

The number of ATCOs per year receiving One-off training has been calculated according to the following formula, in line with the assumptions that one-off training sessions are equally distributed between 2013 and 2020 to train all ROMATSA ATCOs on duty in 2013 (220), as explained in 4.3.5.1.

ATB (t) = 220 ATCOs/(2020-2012) = 28 ATCOs/year

OTC(t) = CTB(t)*ATB(t)*TBD(t)

8.2.9 ATCO staff cost avoidance calculation

ATCO's staff cost avoidance is calculated as per the formula of Table 26 repeated here for convenience:

$$ASCA(t)=[ACR(t)\cdot ASAR(t)+ACB(t)\cdot ASAB(t)]\cdot ACAU(t)$$

The different terms in the equation above are calculated as follows,

$$ASAR(t) = (ATCO_{BAS}(t) - ATCO_{FAB}(t))_{ROMATSA}$$

$$ASAB(t) = (ATCO_{BAS}(t) - ATCO_{FAB}(t))_{BULATSA}$$

Where:

$ATCO_{BAS}(t)$ - Annual total ATCOs in Baseline scenario

$ATCO_{FAB}(t)$- Annual total ATCOs in FAB scenario

$ATCO_{BAS}(t)$ *and* $ATCO_{FAB}(t)$ are repeated in Table 68 for convenience.

	ROMATSA		BULATSA	
	2012	2030	2012	2030
Total ATCO FAB scenario ($ATCO_{FAB}$)	220	275	95	121
Total ATCO Baseline scenario ($ATCO_{BAS}$)	220	286	95	139

Table 68: Number of ATCOs in 2012 and 2030.

ACR(t) and ACB(t) are calculated from [6]:

$$ACR(t) = ACR(t-1)\ INF_R(t)$$

$$ACB(t) = ACB(t-1)\ INF_B(t)$$

Where, $INF_R(t)$ *and* $INF_B(t)$ are the inflation rates from ROMATSA and BULATSA, respectively, and taken from [6]. Note that time "t" takes entire values between 2013 and 2030. Salary costs for ATCOs are assumed to increase by 1% over inflation, in line with the assumption made in SESAR D4.

Initial values of ACR and ACB for 2010 are summarized in Table 69:

Variable	Cost per ATCO
ACR (2011)	70359 €
ACB (2011)	66483 €

Table 69: ATCO cost [6]

Since the amount of traffic has a direct impact on the number of ATCOs in operations required, the ATCOs staff cost avoidance uncertainty (ACAU) is defined in line with high, base and low scenarios traffic forecasts. Thus, ACAU uncertainty range has been calculated for each of the two ANSPs separately, according to the following equations:

$$ACAU_{high}(t) = \frac{AT|_{y,high}}{AT|_{y,base}}$$

$$ACAU_{base}(t) = 1$$

$$ACAU_{low}(t) = \frac{AT|_{y,low}}{AT|_{y,base}}$$

For 2012<t<2030. Where,

y - represents the year of computation, i.e., 2013-2030.

AT- represents the annual traffic forecast for each year y, according to the high or base STATFOR growth scenarios for each Country separately.

ACAU (t) is plotted for ROMATSA and BULATSA as seen in Figure 55 and Figure 56.

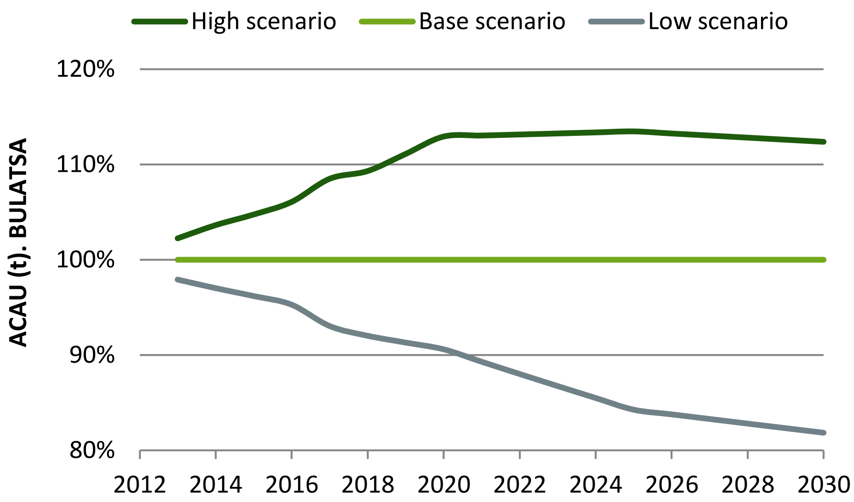


Figure 55: ATCO cost avoidance uncertainty for BULATSA

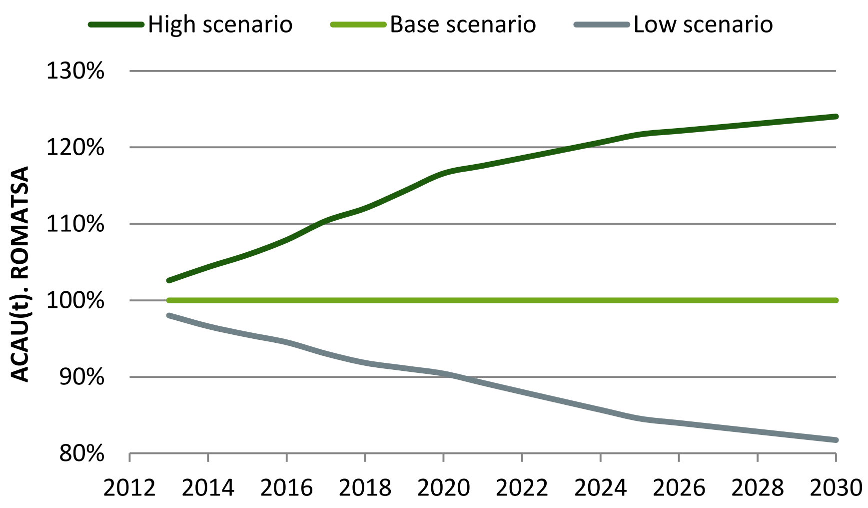


Figure 56: ATCO cost avoidance uncertainty for ROMATSA

8.2.10 ATCO initial training cost avoidance calculation

ATCO initial training cost variables included in Table 26 of section 4.3.5.1 (ATCR, ATCB, ANAR and ANAB) have been calculated as follows:

$$ATCR\ (t) = ATCR\ (t\text{-}1) INF_R(t)$$

$$ATCB\ (t) = ATCB\ (t\text{-}1) INF_B(t)$$

For 2012<t<2031. Where,

ATCR (2012) are the annual ATCO initial training costs for ROMATSA, provided by experts and equal 16320 €/year.

ATCB (2012) are the annual ATCO initial training costs for BULATSA, provided by experts and equal 41120 €/year.

The number of new ATCOs avoided is derived as the correspondent delta figure existing between baseline and FAB scenarios and is obtained as follows:

$$ANAR(t) = [(ATCO_{BAS}(t)-ATCO_{BAS}(t-1)) - (ATCO_{FAB}(t)-ATCO_{FAB}(t-1))]_{ROMATSA}$$

$$ANAB(t) = [(ATCO_{BAS}(t)-ATCO_{BAS}(t-1)) - (ATCO_{FAB}(t)-ATCO_{FAB}(t-1))]_{BULATSA}$$

Where, $ATCO_{BAS}(t)$ stands for Annual total ATCOs in Baseline scenario and $ATCO_{FAB}(t)$ stands for Annual total ATCOs in FAB scenario (see Table 68). This calculation is true only if it is assumed that the number of retired ATCOs is the same in both scenarios

Since traffic volume has a direct impact on the number of new ATCOs to be incorporated, the ATCOs initial training cost avoidance uncertainty (ATCAU) is defined in line with high, base and low scenarios traffic forecasts (in the same manner than ACAU). Thus, ATCAU is equal to ACAU and defined as follows.

$$ATCAU_{high}(t) = \frac{AT|_{y,high}}{AT|_{y,base}}$$

$$ATCAU_{base}(t) = 1$$

$$ATCAU_{low}(t) = \frac{AT|_{y,low}}{AT|_{y,base}}$$

For 2012<t<2031. Where,

y - represents the year of computation, i.e., 2013-2030.
AT- represents the annual traffic forecast for each year y, according to the high or base STATFOR growth scenarios for each Country separately.

ATCAU(t) has the same functional shape than ACAU (t), plotted in Figure 55 and Figure 56 for BULATSA and ROMATSA, respectively.

8.2.11 Harmonized training system model

ANR and ANB are derived as follows:

$$ANR(t) = [\Delta ATCOs_{FAB} + ATCOs_{retired}]_{ROMATSA} = [[ATCO_{FAB}(t) - ATCO_{FAB}(t-1)] + New\ ATCOs\ Baseline + [ATCO_{BAS}(t) - ATCO_{BAS}(t-1)]]_{ROMATSA}$$

$$ANB(t) = [\Delta ATCOs_{FAB} + ATCOs_{retired}]_{BULATSA} = [[ATCO_{FAB}(t) - ATCO_{FAB}(t-1)] + New\ ATCOs\ Baseline + [ATCO_{BAS}(t) - ATCO_{BAS}(t-1)]]_{BULATSA}$$

Subsequently, BA(t) has been calculated in order to capture the progressive benefits achieved in terms of harmonized training system, due to the gradual level of harmonization achieved between 2013 and 2017. It is defined as a ramp function as follows,

$$BA(t)=0,\ t < 2013$$

$$BA(t)=(t-2012)/(2017-2012);\ 2012 < t < 2018$$

$$BA(t)=1;\ t > 2017$$

8.2.12 Common CNS strategy costs avoidance

Capital cost avoidance of CNS equipment (Radar - RCA(t), DME - DCA(t) and their sum-CCA(t)) are defined according to a depreciation model based on the lifecycle and according to the assumptions made in section 4.3.5.4:

$$RCA(t) = 1300000\ €/12\ years = 108333€/year;\ 2011 < t < 2023$$

$$RCA(t) = 1846068\ €/12\ years = 153840€/year;\ 2022 < t < 2031$$

Where the base value of 1300000 correspond to the value provided by Technical WG experts, related to 2011 real values, while this value has been discounted to take into account inflation for the purchase of the second radar system.

DCA (2012) was estimated by Technical WG experts, while the correspondent depreciation time series takes the following form

$$DCA(t) = 780000€/15\ years = 52000€/year;\ 2011 < t < 2028$$

$$DCA(t) = 0;2027 < t < 2031$$

Finally, the Capital Cost Avoidance is found as a sum of the depreciation costs avoidance like

$$CCA = RCA(t)+DCA(t)$$

Operating cost avoidance variables are defined according to Table 46, based on data provided by Technical WG experts.

$$ROCA(t) = 30.000;\ 2010< t < 2031$$

$$DOCA(t) = 81.000;\ 2011 < t < 2028$$

$$DOCA(t) = 0\ ;\ 2027 < t < 2031$$

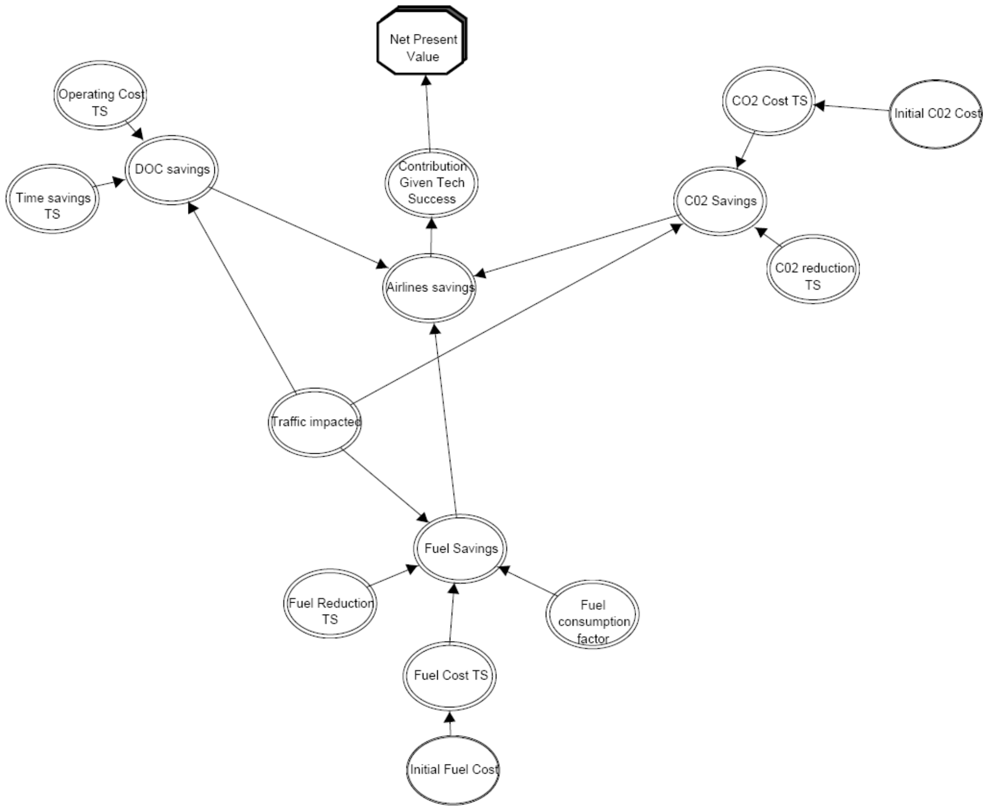
$$AOCA(t) = 0\ ;\ 2012 < t < 2017$$

$$AOCA(t) = 40.000\ ;\ 2016 < t < 2031$$

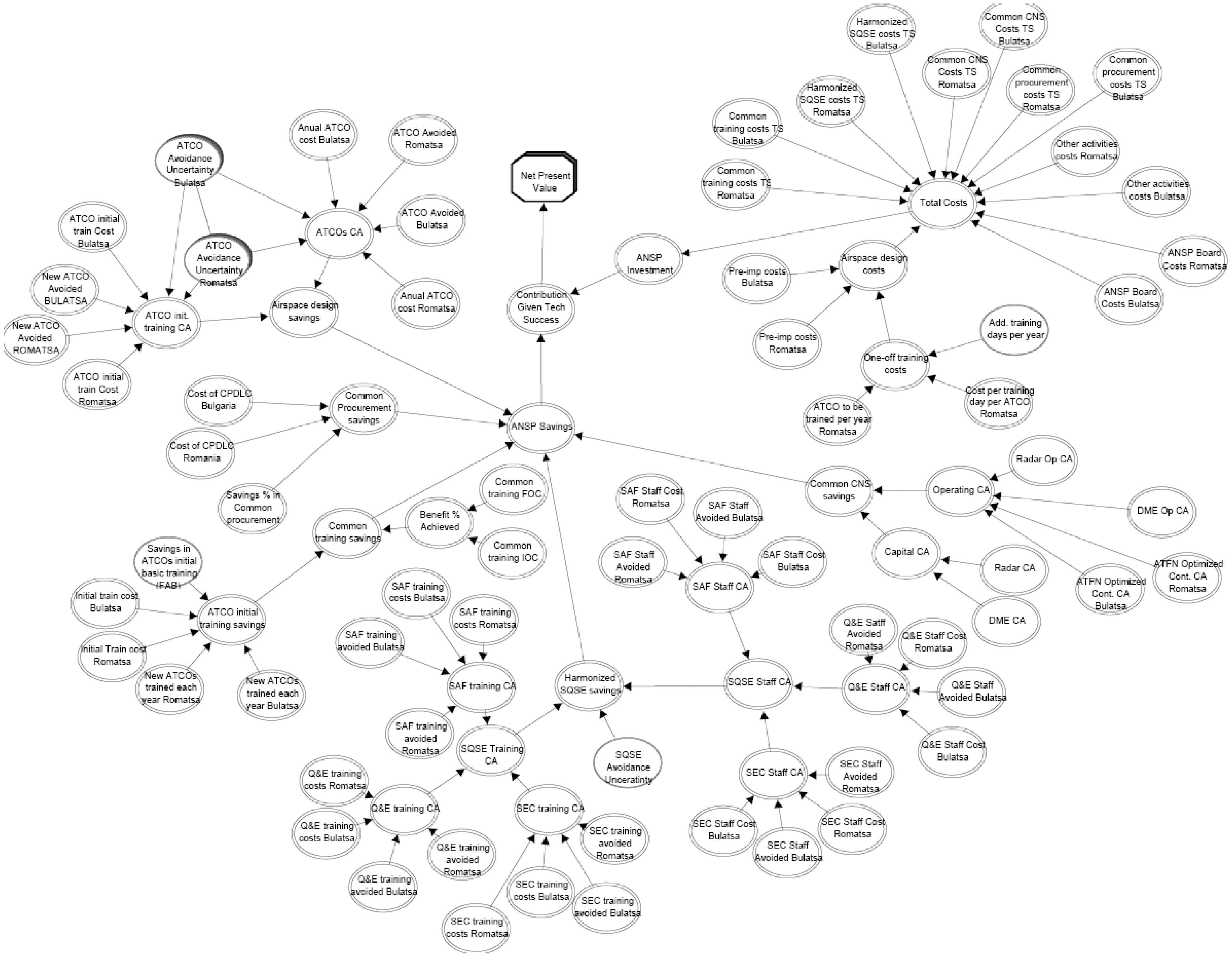
Finally, the operating cost avoidance is calculated like

$$OCA(t) = ROCA(t)+ DOCA(t)+ AOCA(t);$$

8.3 Airline EMOSIA Model



8.4 ANSP EMOSIA Model



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