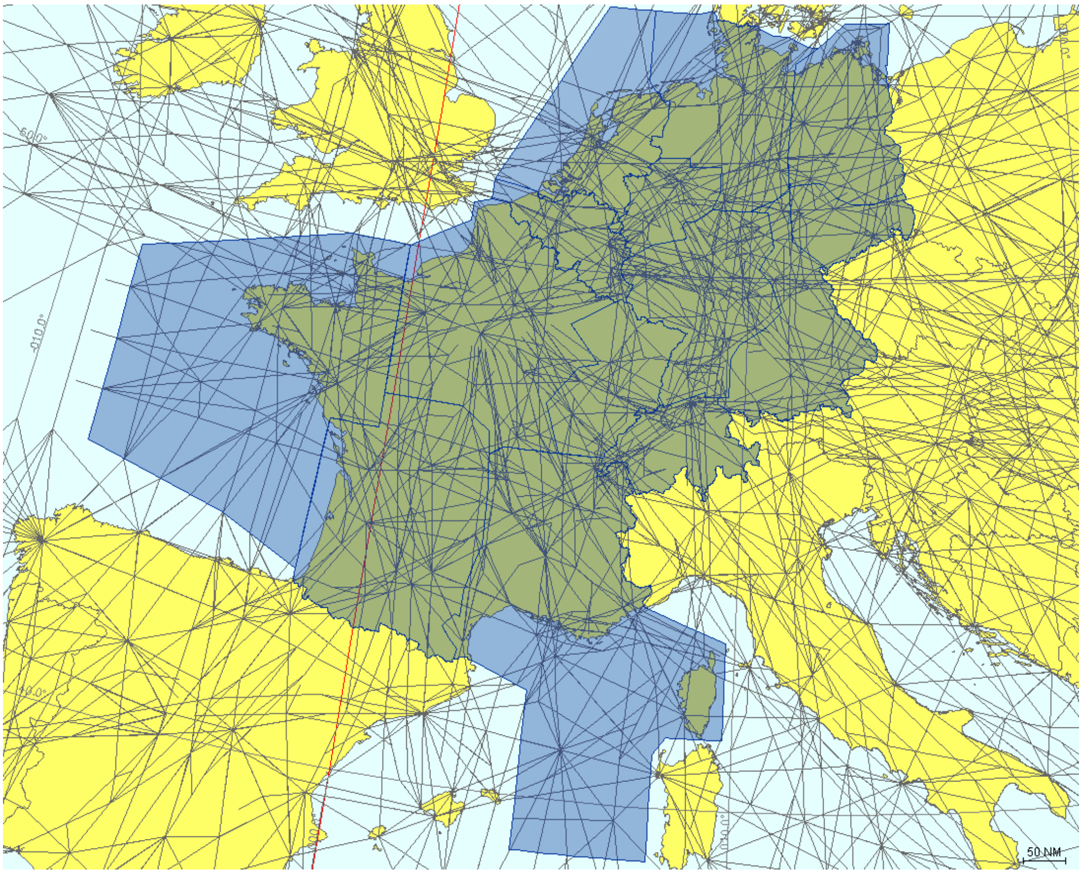
Creating the Functional Airspace Block Europe Central

Feasibility Study Report



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Belgocontrol
Luchtverkeersleiding Nederland
Air Traffic Control the Netherlands
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DFS Deutsche Flugsicherung
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dgac DSNA
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RESULTS OF THE FEASIBILITY STUDY

The FABEC detailed feasibility study has provided an ambitious set of initiatives for cooperation, taking into account the contributions from all relevant partners: States, civil and military ANSPs. If implemented, these initiatives will make a significant contribution towards the goals of the Single European Sky as the airspace will increasingly become a continuum for its users. Clear benefits will be delivered and a considerable step will be made towards meeting the performance targets that have been defined. The study has proven that FABEC is feasible and also necessary to react to future challenges in core area Europe.

Safety*: Provided some specific issues are taken on board in the development phase, the experts indicate that the same high level of safety can be maintained despite the increase in the number of flights.*

Capacity*: In 2018, sufficient capacity can be made available to accommodate increased traffic demand, whilst staying within the target of an average of 1 minute delay per flight. By 2013 it is estimated that the FABEC initiatives will enable to reduce the percentage of flights delayed from 24% to 5% with the average delay per delayed flight being reduced from 12 minutes to 7 minutes. By 2018 it is estimated that further FAB initiatives will even reduce the percentage of flights delayed from 33% to 1% with the average delay per affected flight being reduced from 17 to 6 minutes.*

Cost effectiveness*: The cost-benefit analysis is positive. It shows that in 2025 the potential Net Present Value for the FABEC benefits range between approximately €3,600m and €9,800m. The proposed target of a 17 % reduction of real en-route unit cost by 2018 can be met.*

Flight efficiency*: Without FABEC, flight efficiency in the area is expected to deteriorate over the next years. The FABEC initiatives will contribute significantly to countering this. It is expected that these initiatives improve the horizontal flight efficiency within the FABEC area. It is envisaged that the maximum benefit in terms of flight length in 2018 will be a reduction of 17.4km (9.4NM) per flight compared to today. Compared to the 2018 reference case, this is a reduction of 29km per flight.*

Environment*: In line with the improvements in flight efficiency there will be a significant contribution to reducing the emissions per flight. In 2018 a maximum reduction of 72 kg fuel burnt per flight compared to today is estimated, which is equivalent to a reduction of emissions per flight of 226kg of CO2 and 0.7kg of NOx. Compared to the 2018 reference case, the reduction in fuel burnt per flight as a result of implementation of FABEC initiatives is estimated to be 121kg.*

Military mission effectiveness*: FABEC development shall significantly contribute to improve military mission effectiveness by improvements of training capabilities and readiness postures as required by States*

EXECUTIVE SUMMARY

SETTING THE SCENE

In the light of the ongoing discussion about the future of the European air navigation services, the civil and military authorities of 6 States (Belgium, Luxembourg, Netherlands, Germany, France and Switzerland) and air navigation service providers designated in these States launched a feasibility study on the creation of a Functional Airspace Block Europe Central (FABEC). Up to 230 experts from the different ANSPs shared their expertise and created in 18 months a common perspective in regard to the future of air navigation services in the heart of Europe. An intensive consultation process with stakeholders guaranteed transparency right from the beginning.

Based on the challenges expected from the forecasted growth in air traffic, the complexity of the high-density area with the hubs of Paris, Amsterdam, Frankfurt, Munich, Brussels and Zurich and the changing military requirements, and in harmony with the notion of the SES regulations, the FABEC feasibility study was conducted in an overarching approach based on concrete **operational necessities**. This meant that from the very beginning of the study there was a common acknowledgement that with a 'business as usual' approach air traffic will encounter considerable problems in the near future: The expected 50 per cent increase in civil flights by 2018 combined with the fact that delays will increase while flight efficiency will decrease cannot be dealt with on a national basis only. In summary, service quality in a 'business as usual' model will decrease over the next years. Therefore, the experts suggested not only to think beyond national boundaries but also to take the entire airspace (lower and upper airspace) into account and by doing so, the FABEC feasibility study went far beyond the requirements of the Single European Sky package.

To guarantee a holistic view, the experts investigated all aspects of a FABEC framework, for instance:

- The implications on safety
- A common operational understanding and concrete common operational measures, including airspace design
- The technical infrastructure and services
- Civil and military aspects to balance especially the operational requirements
- Institutional and regulatory aspects
- Financial aspects to show the costs and the benefits ratio of FABEC and to develop proposals on common charging including a common unit rate
- Training aspects and potential implications on human resources

On the basis of this common approach, the FABEC feasibility study created proposals for improvement.

EXPECTED RESULTS ACCOMPLISHING THE PERFORMANCE TARGETS

The FABEC study was guided by **common civil and military strategic objectives** which include a set of clear common **performance targets** in the areas of safety, environment, capacity, cost effectiveness, flight efficiency and military mission effectiveness improvements.

SAFETY

***The Target**: The FABEC development shall take all efforts necessary to ensure an improved safety level. This means that, despite the civil traffic growth, the current absolute number of ANS-induced accidents and risk bearing incidents shall not increase or will even decrease.*

***The Result**: Provided some specific issues are taken on board in the development phase, the experts indicate that the same high level of safety can be maintained despite the increase in the number of flights.*

CAPACITY

***The Target**: Develop the airspace capacity so as to meet the demand of increased civil air traffic in the range of 50% by 2018 based on EUROCONTROL STATFOR forecasts, taking into account the current agreed delay target of 1 minute per flight and taking into account the military needs.*

***The Result**: In 2018, sufficient capacity can be made available to accommodate increased traffic demand, whilst staying within the target of an average of 1 minute delay per flight. By 2013 it is estimated that the FABEC initiatives will enable to reduce the percentage of flights delayed from 24% to 5% with the average delay per delayed flight being reduced from 12 minutes to 7 minutes. By 2018 it is estimated that further FAB initiatives will even reduce the percentage of flights delayed from 33% to 1% with the average delay per affected flight being reduced from 17 to 6 minutes.*

COST EFFECTIVENESS

***The Target**: Within FABEC the expected 50% increase in civil traffic by 2018 shall not result in more than 25% increase in total cost based on current rules of cost recovery (leading to a 17% reduction of the real en-route unit cost). On the military side, a decrease in ATM cost shall be realised.*

***The Result**: The cost-benefit analysis is positive. It shows that in 2025 the potential Net Present Value for the FABEC benefits range between approximately €3,600m and €9,800m. The proposed target of a 17 % reduction of real en-route unit cost by 2018 can be met.*

FLIGHT EFFICIENCY

***The Target**: The FABEC development shall significantly contribute to improve the flight efficiency by improvements of routes, flight profiles and distances flown. In 2006 the average extension of flights in the EUROCONTROL area related to the Great Circle distance has been around 48 km. The target will be a reduction in the FABEC area in the average route extension of two kilometres per annum until 2010, increasing to an accumulated total of 10 km by 2018.*

***The Result**: Without FABEC, flight efficiency in the area is expected to deteriorate over the next years. The FABEC initiatives will contribute significantly to countering this. It is expected that these initiatives improve the horizontal flight efficiency within the FABEC area. It is envisaged that the maximum benefit in terms of flight length in 2018 will be a reduction of 17.4km (9.4NM) per flight compared to today. Compared to the 2018 reference case, this is a reduction of 29km per flight.*

ENVIRONMENT

***The Target**: The FABEC development shall contribute to reduce the impact on environment by improvements of routes, flight profiles and distances flown.*

***The Result**: In line with the improvements in flight efficiency there will be a significant contribution to reducing the emissions per flight. In 2018 a maximum reduction of 72 kg fuel burnt per flight compared to today is estimated, which is equivalent to a reduction of emissions per flight of 226kg of CO_2 and 0.7kg of NO_x. Compared to the 2018 reference case, the reduction in fuel burnt per flight as a result of implementation of FABEC initiatives is estimated to be 121kg.*

MILITARY MISSION EFFECTIVENESS

***The Target**: The FAB EC development shall significantly contribute to improvement of military mission effectiveness by improvements of training capabilities and readiness postures as required by States. .*

***The Result**: It is expected that with the proposals made by the experts, the military mission effectiveness will improve. However, further studies are required.*

SOLUTIONS BASED ON A COMMON OPERATIONAL APPROACH

To fulfil these ambitious objectives, the experts have identified a number of areas of cooperation and measures that are expected to bring benefits in the FABEC area. In particular, a **common operational concept** and **airspace design** have been developed. Both initiatives are key elements to solve the challenges expected. In addition, they are a starting point for a further cooperation in the areas of operations, safety, technical systems and services, training and the charging scheme. The operational and technical proposals are fully aligned with SESAR.

The main FAB proposals are:

Common operational concept

Defining a common operational concept is one of the main drivers for the establishment of FAB Europe Central. A common operational concept was defined between all ANSPs, both civil and military, taking the FABEC region as one continuum of airspace. A regional civil/military function for both air traffic flow management and airspace management, the ATFCM/ASM function, forms a central part of the operational concept. Based on existing concepts like SESAR, the concept will contribute to meeting the needs of airspace users by delivering increased capacity and flight efficiency.

The common operational concept focuses, among other things, on:

- Balancing of demand and capacity
- Airspace organisation and management - including all Flexible Use of Airspace elements - to meet all users' needs
- Integrated decision-making process as if the airspace is controlled from one control centre

Airspace design

The FABEC airspace was designed irrespective of national borders for both civil routes and sectors, and military training areas. This approach will mainly deliver benefits through enabling an optimised route structure over a wide area, reducing controller workload by moving sector interfaces to less critical areas, and increasing the options for military training area locations.

Military partners were actively involved in the airspace design work. Airspace use requirements were thoroughly integrated into the designs. Some areas were identified where an imbalance exists between the future military airspace needs and civil traffic demand, further study is required to meet both civil and military requirements.

The airspace was designed at the level of sector families - groups of closely interdependent sectors. Several scenarios were developed based on different design criteria.

Convergence towards common technical systems

Technical measures have been identified which enable the timely implementation of the common operational concept, overcome the present fragmentation of ATM systems in the core area of Europe and ensure that future developments follow a joint roadmap towards common technical [sub-]systems and common technical services. The study focussed on a wide range of technical systems supporting ATS, CNS and ATFCM/ASM functions. The roadmap foresees a convergence towards a common ATS system based on two products and 21 technical cooperation areas.

The study has produced a roadmap for common technical systems, which covers the major medium to long term technical developments. The roadmap covers progression in cooperation which ranges from planning and specification, through an intermediate stage featuring greater cooperation through joint procurement and development activities to possible joint training and maintenance of systems.

Common safety management

The first priority of air navigation service provision is safety. Safety is considered a prerequisite of implementing FABEC, irrespective of the content of the operational concept, airspace design or any other aspect of the cooperation.

Considering the early stage of the development of FABEC, a full safety case cannot yet be delivered. Instead, a ‘safety feasibility indication’ was produced, giving an indication of the likelihood of meeting the overall safety objective once the FAB was designed. According to the output of the study, there is justified, expert-based confidence that a FAB based on the common operational concept can be made sufficiently safe.

Harmonisation of safety management systems of the individual ANSPs into a common SMS at FAB level will support the FAB in achieving improvements in safety. A staged approach to development towards a common SMS has been proposed.

Part of the proposal is a FAB Safety Management Office. This office would be responsible for issues such as developing safety targets, monitoring performance and reporting to the FABEC governing body.

Common charging scheme

The study recommends that the whole airspace of FAB Europe Central should constitute a single charging zone with a single en route unit rate. This will be an enabler for airspace design independent of national borders, and bring benefit in the form of reducing inefficient routing to minimise user charges.

Therefore, the cost bases of the Member States of FABEC will be pooled to establish a single cost base for the zone. The unit rate for the charging zone will then be derived from this single cost base. Revenues will be shared in the ratio of the individual cost bases.

Cooperation in training

Cooperation in training has been identified as a measure adding sustainable economic value, becoming effective gradually on a short term basis.

Implementation of a common operational concept in combination with convergence in common technical systems and services will enable the opportunity for cooperation in the area of ATCO and ATSEP training. Such cooperation can improve cost effectiveness, and may also improve the effectiveness of the application of the operational concept as well as the harmonization of technical systems. A common supervisory authority and a harmonised regulatory framework would be efficient enablers to get full benefits from cooperation in training.

In the long term, a single training organisation will be possible, though one single location seems not advisable from a quality and cost perspective. This single training organisation will preserve the continuum of training covering selection and recruitment and all phases of training. Cooperation in training between civil and military will be possible but needs further investigation.

Other opportunities

Potential cooperation in the areas of AIS, MET and contingency concepts has been identified, but this will require further study on the way forward before options for implementation can be defined.

THE COST-BENEFIT ANALYSIS HAS YIELDED POSITIVE RESULTS

One central decision criterion for the creation of a FAB is a positive cost-benefit analysis. Therefore an external consultant was asked to make this analysis on the basis of the widely accepted Performance Review Unit methodology. This methodology identifies on the one hand direct cost savings (noticeable in reduced charges) and on the other hand direct savings for the airlines due to better service. Both effects are summed up in a so-called metric for economic cost-effectiveness.

The starting point is the reference case. This ‘business as usual’ scenario was built on the latest actual data, LCIPs and individual business plans for the years up to 2012 and commonly agreed assumptions afterwards. The experts concluded that the cost of service provision will decrease, but the quality will decline (more delays, less flight efficiency). Due to this fact, the overall economic cost per flight hour for airspace users is expected to rise in the FABEC area.

The feasibility study considered a wide range of cooperative initiatives triggered by a common operational concept, improved airspace design and a coordinated development and implementation of the technical infrastructure. Enhanced cooperation in the areas of training, MET, AIS and contingency concepts was also included. The study also recommends the implementation of a single unit rate at FABEC level, which will support optimal airspace design and flight efficiency.

The results show that the FABEC initiatives remedy the decline in economic cost effectiveness foreseen in the reference case by maintaining a high quality of service, through a decrease in delay and an increase in flight efficiency. They also reduce the costs of service provision further compared to the reference case. The FAB benefits show a positive Net Present Value, even over relatively short time horizons. By 2025, the potential Net Present Value of the FABEC benefits ranges between approximately €3,600m and €9,800m, depending on the sensitivity analysis.

INSTITUTIONAL CHANGES ARE REQUIRED

The study investigated the requirements for the institutional framework necessary to enable the implementation of the improvements identified in the different areas and analysed potential legal forms for this framework.

Three models of cooperation were studied that are considered to meet requirements of a FAB:

- **Contractual cooperation**: independent ANSPs cooperating in a contractual framework between the parties, without establishment of a joint legal entity. A joint committee will be installed to lead the development of improvements in the different areas of cooperation. Implementation of improvements will take place inside the individual ANSPs, not by the establishment of centralised functions.

- **Integration into an alliance**: independent ANSPs cooperating in the field of ATS provision, integration of functions into centralised legal entities may take place in the field of support functions, ancillary services and the establishment of joint ATS units, requiring the establishment of joint legal entities with dedicated resources, delegated executive functions. Different scenarios are possible for integration of ancillary services.

- **Consolidation into a single ANSP**: integrated ATS service provision throughout the FABEC. Integration of ancillary services may take place inside the single ANSP or may be left to separate initiatives of ANSPs (possible with different speeds) or outsourcing of ancillary services.

The principal distinction between contractual cooperation and the two other models is that in the contractual model no integration of function takes place. Joint units require legal entities which are foreseen both in the alliance and the single ANSP model.

The study analysed the different areas of improvement where a structured cooperation will be required to enable their implementation. The main conclusions from this analysis are:

- A progressively growing level of cooperation will be the most suitable approach

- In terms of cooperation requirements 2 types of improvements can be identified:

  - Areas where the initiatives will be implemented inside the individual ANSPs. The ANSPs jointly agree about the improvements, but each of them will be responsible for the implementation in their own organisations.

  - Areas where the implementation of the improvements require centralisation of functions.

Contractual cooperation and an alliance are possible ways to organise the cooperation. The single ANSP model might be a necessary enabler for the full operational improvements, but this requires further study.

Involvement of military partners in the different institutional models of cooperation is to be clarified and will require decisions at national level. However, in general, military partners have recognised that in a number of areas win-win situations are more realistic in stronger cooperation models.

Different legal forms were investigated but further study is needed based on policy decisions.

SOCIAL ASPECTS

The implementation of the FAB will provide many opportunities for staff, as the new international environment widens the horizon and creates new challenges.

The social impact of the implementation of FABEC will depend on different aspects like the areas of cooperation, on the level of this cooperation, and on the institutional model that is chosen. In a model using contractual cooperation only, impact on working conditions and staffing will be limited. If integration into an alliance is considered, some functions may be centralised, and impact at the level of individual organisations need to be determined. Steps need to be taken to ensure that integration occurs in a socially acceptable manner and associated transition costs need to be considered. This would include the costs related to, among other things, mobility of personnel, harmonisation of working conditions and this regardless of the institutional model that is chosen. This statement will also apply to and indeed be even more significant in the single ANSP scenario, when the different organisations are fully integrated.

Involvement of social partners in the social dialogue process and open and thorough information to staff are key contributors to the success of the FABEC implementation.

SUSTAINABLE STEPS INTO THE FUTURE

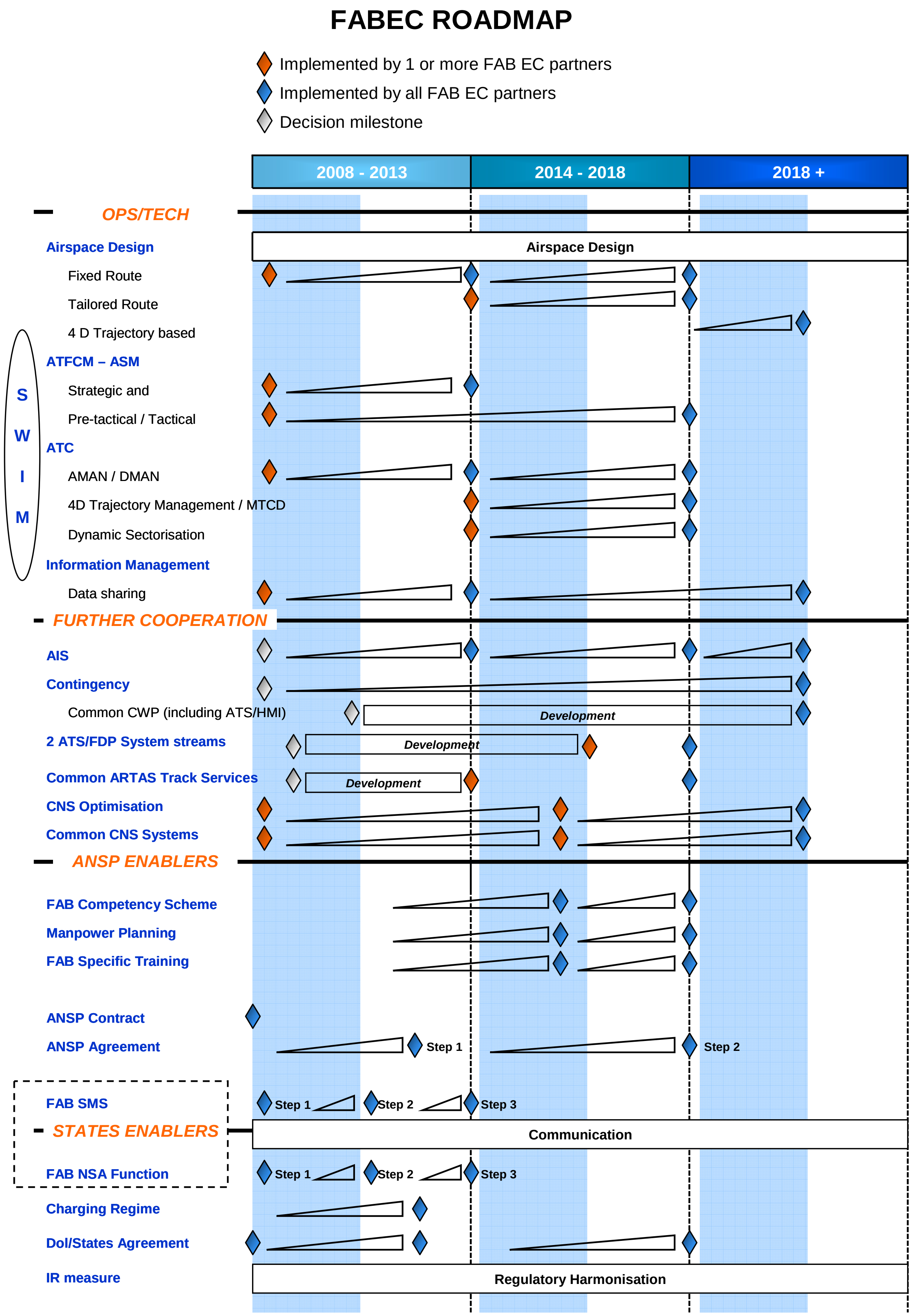
Driven by the operational necessity to improve air traffic control in the heart of Europe in the short and medium run, and following the consensus that in the future air traffic control in the entire airspace has to be organised irrespective of national boundaries, the experts propose a wide range of activities to be taken. It is obvious that a sustainable improvement can only be reached if the different activities are combined, coordinated and prioritised. Therefore a high level FABEC roadmap was developed to show the interdependencies between the different implementation packages and/or the enablers - at State or at ANSP level.

The leading element of the FABEC roadmap is the common operational concept. The implementation plan of this concept foresees three main steps in its development: initial elements in 2009, further development by 2013 (including so-called 'short term priorities and first benefits') and full implementation after 2018. Closely related are the airspace design developments and the technical roadmap.

Other main elements of the FABEC roadmap are a common SMS to be in place by 2013, a common charging scheme to be in place before the same time as the introduction of cross-border operations (estimated to be 2013) and human resource related enablers for the operational and technical issues.

To enable an effective implementation of the identified areas of cooperation in line with the FABEC roadmap, the States need to address a number of measures in the field of legislation and regulation. These measures cover issues such as designation, liability, licensing and safety. Furthermore, harmonisation of rules and procedure in a wide area of fields (operational, technical, financial, etc.) is necessary.

Due to the fact that the negotiation and ratification of a Treaty needs time and that there are some improvements which can be taken by the ANSPs already, a joint and parallel approach is required. Therefore the experts recommend to start immediately an ANSP cooperation, with both civil and military ANSPs, in areas where appropriate and where no Treaty is needed. In addition, to avoid losing time, preparation steps for the implementation of key functions, such as internal FABEC cross-border areas and FABEC flow management should be taken as soon as possible.


FABEC ROADMAP
Implemented by 1 or more FAB EC partners
Implemented by all FAB EC partners
Decision milestone
2008 - 2013
2014 - 2018
2018 +
OPS/TECH
Airspace Design
Airspace Design
Fixed Route
Tailored Route
4 D Trajectory based
ATFCM – ASM
Strategic and
Pre-tactical / Tactical
ATC
AMAN / DMAN
4D Trajectory Management / MTCD
Dynamic Sectorisation
Information Management
Data sharing
S
W
I
M
FURTHER COOPERATION
AIS
Contingency
Common CWP (including ATS/HMI)
Development
2 ATS/FDP System streams
Development
Common ARTAS Track Services
Development
CNS Optimisation
Common CNS Systems
ANSP ENABLERS
FAB Competency Scheme
Manpower Planning
FAB Specific Training
ANSP Contract
ANSP Agreement
Step 1
Step 2
FAB SMS
Step 1
Step 2
Step 3
STATES ENABLERS
Communication
FAB NSA Function
Step 1
Step 2
Step 3
Charging Regime
DoI/States Agreement
IR measure
Regulatory Harmonisation

CONCLUSION

The FABEC Detailed Feasibility Study has provided an ambitious set of initiatives for cooperation, taking into account the contributions from all relevant partners: States, civil and military ANSPs. If implemented, these initiatives will make a significant contribution towards the goals of the Single European Sky as the airspace in core area Europe will increasingly become a continuum for its users. Clear benefits will be delivered and a considerable step will be made towards meeting the performance targets that have been defined. The study has proven that FABEC is feasible and also necessary to react to future challenges in core area Europe.

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SECTION I: INTRODUCTION

1 Background

This report provides the results of a study into the feasibility of the Functional Airspace Block Europe Central, covering the airspace of Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland. The objective of the study is to propose initiatives to increase ATM performance in safety, capacity, flight efficiency, cost effectiveness, military mission effectiveness and environmental impact.

This report presents the results of a detailed feasibility study into the implementation of a functional airspace block (FAB) in the core area of European airspace, known as 'FAB Europe Central', or 'FABEC'. FABEC involves the civil and military authorities of six States (Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland) and the air navigation service providers (ANSPs) designated in these States.

The aim of the report is to respond to the questions posed by the six States involved, in terms of the opportunities for initiating a FAB and the benefits it is expected to bring. The report describes the areas in which cooperation can be foreseen and indicates the effects that such cooperation is expected to have on performance.

1.1 What is a FAB?

To meet the future needs and challenges of a growing air travel and transport industry, the European Commission launched the Single European Sky (SES) initiative. The Single Sky regulations came in to force in April 2004, with the aim of initiating the redesign of European Air Traffic Management (ATM) as a flexible, harmonised and seamless network, independent of national boundaries. The Single Sky aims to optimise airspace usage and capacity to minimise restrictions related to air traffic control and maximise airport throughput.

The Single Sky will address a wide range of shortcomings in the ATM industry. While some of these shortcomings may be resolved with incremental improvements to existing operations, others will require more fundamental changes. The ultimate objective is to fulfil the expectations within the ATM industry beyond 2020.

The Single Sky Regulations include the Airspace Regulation [Ref. 1]. Article 5 of this regulation requires that the following: "*With a view to achieving maximum capacity and efficiency of the air traffic management network within the single European sky, and with a view to maintaining a high level of safety, the upper airspace shall be reconfigured into functional airspace blocks.*"

The concept of FABs is not fully specified in the legislation, however, Article 5 does set out the principles on which a FAB should be developed. Responsibility for proposing FABs was given to Member States, with the expectation that ANSPs would play a major role in preparing such proposals. The FABEC States have decided on the ambitious strategy of addressing both upper and lower airspace within the feasibility study, involving all relevant ANSPs, to create one continuum of airspace in the FABEC area of responsibility.

FAB Europe Central has the commitment of the six States and seven civil air navigation service providers and military partners to increase ATM performance in safety, the environment, capacity, flight efficiency, cost effectiveness and mission effectiveness; all to meet the challenges of a growing industry.

1.2 Why the FABEC countries?

The core area of Europe has one of the highest traffic densities in the world. The FAB Europe Central airspace, totalling 1,713,442 km^2, is characterised by closely interlaced civil and military traffic routes.

The area includes most of the busiest European airports, and its civil and military airports are in close proximity to one another. These factors result in dense terminal and en-route air traffic, constrained to flow between military training areas.

The seven air navigation service providers of the six States share a common vision:

> *Achieve common performance-oriented solutions irrespective of national boundaries as the result of a joint functional airspace block development encompassing the complex airspace of these six States.*

The overarching objective is that FAB development shall be based on intensive and close cooperation between the involved ANSPs, together with enhanced civil/military cooperation, and as a jointly developed and operated FAB. FABEC must also account for its interface to neighbouring States (or indeed, FABs) – for the benefit of the entire European ATM network.

The United Kingdom is linked to FABEC as a cooperative partner. This involvement acknowledges the close interaction of FABEC airspace with UK airspace and in particular with the main airports in the London area.

1.3 Purpose of this study

Launched in 2006, the detailed feasibility study is the basis for the six States to decide whether to establish FAB Europe Central. The aim of the study is to identify possible areas for cooperation with the aim of improving performance, and to propose an implementation plan for these areas, towards the realisation of FAB Europe Central.

The feasibility study is only the first phase of the move towards an operational FAB. Pending the decisions following its outcome, the six States and the civil and military ANSPs may commit to FAB planning and implementation phases.

1.4 Organisation of this study

The study is a collaborative effort of the Ministries of Transport and of Defence of the six States, and of the civil and military air navigation service providers. This collaborative effort is reflected in the project structure. The following project bodies were involved:

- The **High Level Policy Group** (HLPG) is responsible for issuing the policies and guidelines for the creation of FAB Europe Central. The HLPG consists of the Directors General of Civil Aviation of the six States, the CEOs of the civil ANSPs and the military equivalents from the MoDs and military ANSPs.
- The **Steering Group** (SG) is responsible for assessing the processes, progress and results of the work and for giving appropriate guidance when and where required. The SG consists of representatives of all ministries of transport and defence and civil and military ANSPs.

- The **Project Management Office** (PMO) is responsible for the conduct of the project and the timely achievement of the tasks of the different Working Groups. The PMO consists of the Project Manager and the Chairmen of all Working Groups, with the provision that all civil ANSPs have at least one representative in the PMO.
- The seven **Working Groups** produced the feasibility study deliverables. Membership of the Working Groups is open to all partners of the project (both civil and military). The main effort to support the work of the Working Groups was provided by the civil ANSPs.
- The **Communications Group** supports the PMO in internal and external communications.

As a cooperative partner, the UK has been represented in the HLPG and SG and in the Operational, Technical and Civil/Military Working Groups.

The project structure is presented in Figure 1.

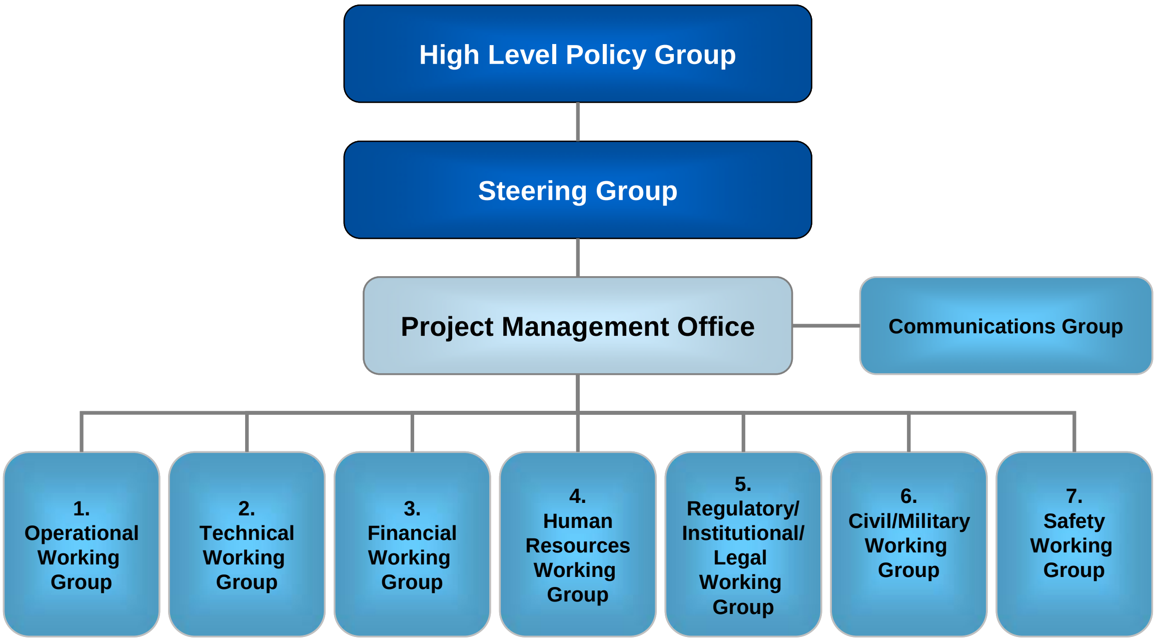

Figure 1 Project organisation structure

1.5 Consultation process

In addition to the internal structure of the project, a consultation process has been carried out during the study, to gather views from external stakeholders. In particular, dedicated meetings were held with representatives from staff unions as well as with representatives from airspace users, at both national and FAB-wide level. Details of this process are provided in Annex C.

2 Project framework

The FABEC detailed feasibility study has been performed within the context of internal guidance by the States and by the air navigation service providers involved. External aspects such as SESAR, the interfaces with neighbouring airspace and the High Level Group report have been taken into account.

2.1 Internal framework

The project framework is governed by three main documents: the Project Charter [Ref. 2], the FABEC view on strategic directions [Ref. 3] and the strategic objectives of the six States for the development of FABEC until 2020 [Ref. 4].

Project charter

The Project Charter defines the project structure, roles and responsibilities and expected outputs. It also poses the questions that the detailed feasibility study, and in particular this feasibility study report, aims to answer.

FABEC view on strategic directions

Whereas the Project Charter provides a high level overview of project scope, organisation and expected outputs, the civil/military 'FABEC view on strategic directions' gives more direct guidance to the Working Groups.

The view on strategic directions translates the questions posed in the Project Charter to more explicitly defined performance targets that have been set for FABEC (see Section 2.3 below for details). To set these performance targets, the targets of SESAR ([Ref. 5]), targets described in the Performance Review Report for 2006 ([Ref. 6]) and relevant agreements of the Provisional Council of EUROCONTROL have been taken as reference.

The paper also identified the potential levels of cooperation, and indicates the most promising areas of improvement.

FABEC - the six States strategic objectives

The strategic objectives of the States provide further support to the direction for performance targets and the continuous improvement of the performance of the FAB. The States aim to govern closely the evaluation of the fulfilment of the targets.

Furthermore, the States provide objectives for ANSP cooperation and for civil/military cooperation.

2.2 External framework

In addition to the SES legislation mentioned before, there are other European developments in the aviation industry and air traffic management that need to be taken into account in the development of FABEC.

SESAR

SESAR (Single European Sky ATM Research) is the European air traffic control infrastructure modernisation programme. SESAR aims to develop the new generation air traffic management system capable of ensuring the safety and fluidity of air transport over the next 30 years.

Under SESAR, European aviation stakeholders (civil and military, legislators, industry, operators and users) have come together in defining, committing to and implementing a pan-European programme. SESAR will contribute to eliminating the fragmented approach to ATM in Europe.

The SESAR programme is composed of three phases:

- **Definition phase (2004 - March 2008)** to deliver an ATM master plan defining the content of the next generation of ATM systems, and plans for its development and deployment.
- **Development phase (2008 - 2013)** to produce the required new generation of technological systems and components as defined in the definition phase.
- **Deployment phase (2014 - 2020)** for large scale production and implementation of the new air traffic management infrastructure, composed of fully harmonised and interoperable components to guarantee high performance air transport activities in Europe.

As presented in the SESAR D4 milestone deliverable ([Ref.7]), FABs will need to take place to close the performance gap with special regard to cost effectiveness for which the SESAR cost-benefit analysis (CBA) has resulted in a shortfall compared with the target. The alignment between SESAR and various FAB initiatives underway is expected to deliver further and additional benefits in terms of enabling a more common operational concept and technical system and the creation of economies of scale: this alignment is therefore considered as a critical point for success.

High Level Group report

The High Level Group (HLG) for the Future European Aviation Regulatory Framework was appointed by European Commission Vice President Barrot in November 2006 in response to strong demand from industry, EU Member States and other stakeholders to simplify and increase the effectiveness of the regulatory framework for aviation in Europe.

In its report (Ref. 8]), the HLG concluded that the principal challenge for Europe is not to embark on new system changes but to focus on accelerating the effective delivery of the existing initiatives – particularly FABs – and to strengthen the capabilities of the key players to deliver them.

Neighbouring FABs

As part of its ongoing study into FABs and their contribution to performance improvement, the Performance Review Commission (PRC) has stated that FAB interfaces account for a considerable contribution to sub-optimal flight efficiency and therefore that there are significant benefits to be gained from well-coordinated interfaces between FABs.

The development of FAB Europe Central must take into account the interfaces with its neighbours in terms of airspace design and the route network, flow management, information management, interoperability, etc. Of particular importance and interest is the interface with UK airspace, which is being addressed through involvement of the UK in FABEC as a cooperative partner.

2.3 Decision criteria

The decision criteria for the feasibility of FAB Europe Central were initially defined in the Project Charter and later expanded to include performance targets in the 'FABEC view on strategic directions'. The main decision criteria are:

- Increased safety
- Reduced environmental impact
- Increased capacity
- Increased cost effectiveness
- Increased flight efficiency
- Increased mission effectiveness

In addition to the above, additional criteria and added values are identified. These include among other things compliance with SES regulations, development of a realistic institutional roadmap and of a socially acceptable implementation plan.

Based on these criteria, the following performance targets were agreed by the ANSPs:

- The FABEC development shall take all efforts necessary to **ensure an improved safety level**. This means that, despite the civil traffic growth the current absolute number of air navigation services (ANS) induced accidents and risk bearing incidents shall not increase or will even decrease.
- The FABEC development shall contribute to **reduce the impact on environment** by improvements of routes, flight profiles and distances flown.
- **Develop the airspace capacity so as to meet the demand** of increased civil air traffic in the range of 50% for 2018 based on EUROCONTROL STATFOR forecasts, taking into account the current agreed delay target of 1 minute per flight and taking into account the military needs.
- Within FABEC **the expected 50% increase of civil traffic by 2018 shall not result in more than 25% increase of total cost** based on current rules of cost recovery (leading to a 17% reduction of the real en-route unit cost). On the military side, a decrease in ATM cost shall be realised.
- The FABEC development shall **significantly contribute to improve the flight efficiency** by improvements of routes, flight profiles and distances flown. In 2006 the average extension of flights in the EUROCONTROL area related to the great circle distance has been around 48 km. The target will be a reduction in the FABEC area in the average route extension of two kilometres per annum until 2010, increasing to an accumulated total of 10 km by 2018.
- The FAB EC development shall **significantly contribute to improvement of military mission effectiveness**.

These performance targets have been used as the reference for the developments in the feasibility study.

SECTION II: CURRENT SITUATION

3 Description of the current situation

The FABEC airspace is one of the densest in the world. In 2006 5.3 million IFR flights - approximately 56% of all flights in the ECAC area - were controlled. In addition a high complexity is given due to the fact that a number of major hubs and military training areas are located in the core area covered by FABEC. Service provision in the FABEC area is characterised by different types of organisation. In 2006 the total ANS revenue of the FABEC is estimated as €2,876m.

3.1 Airspace and traffic

The FABEC airspace comprises the flight information regions (FIRs) of Bremen, Langen, Munich, Amsterdam, Brussels, Paris, Reims, Marseille, Bordeaux, Brest, the upper information regions (UIRs) of Hannover, Rhein, Brussels, France and the FIR/UIR of Switzerland. These FIRs and UIRs contain around 240 airports with instrument flight rules (IFR) operations, some 410 military/special areas and around 370 control sectors.

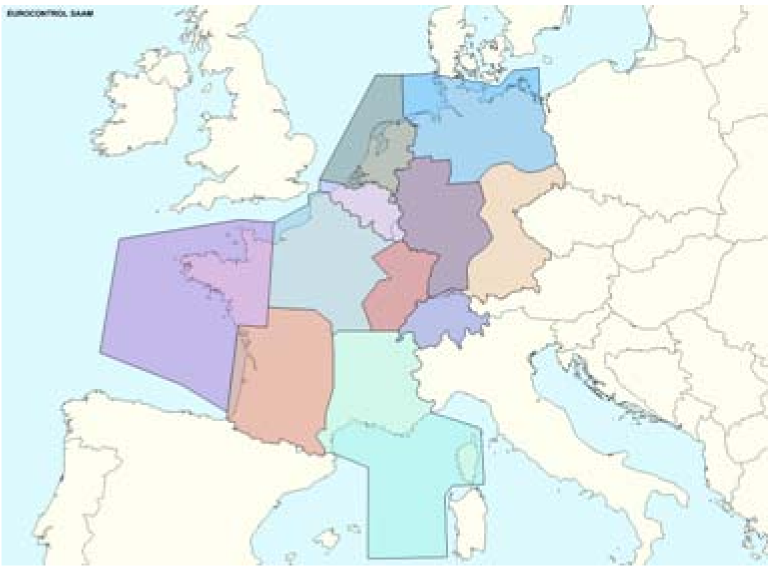

Figure 2 FIRs in the FABEC area

The FABEC ANSPs control some of the highest density of traffic in the world. In 2006 the civil ANSPs of the FABEC area controlled 5.3 million Instrument Flight Rules (IFR) flights, which is approximately 56% of all flights in the European Civil Aviation Conference (ECAC) area.

Over-flights account for 22% of the flights entering the FABEC region, and 26% of all flights are internal flights within the FABEC region. The remaining 52% of flights within FABEC are those arriving from or departing to countries outside of FABEC.

	FABEC (2006)
Over-flights	1.2 million
Internal flights	1.4 million
Arriving from/departing to countries outside FABEC	2.7 million
Total IFR flights controlled	5.3 million

Table 1 FABEC traffic statistics (2006)

The number of IFR flights controlled by each FABEC ANSP increased by between 2.5% and 5.9% in 2006, compared to 2005. This traffic increase is expected to continue in the future, with an estimate that demand will increase by between 32% and 47% in 2018 compared to 2006. Figure 3 shows the traffic flows in FABEC along the current route network for a single day. It shows high traffic density in the central core area and also surrounding the major airports in Paris, Amsterdam, Frankfurt, Munich, Brussels and Zurich.

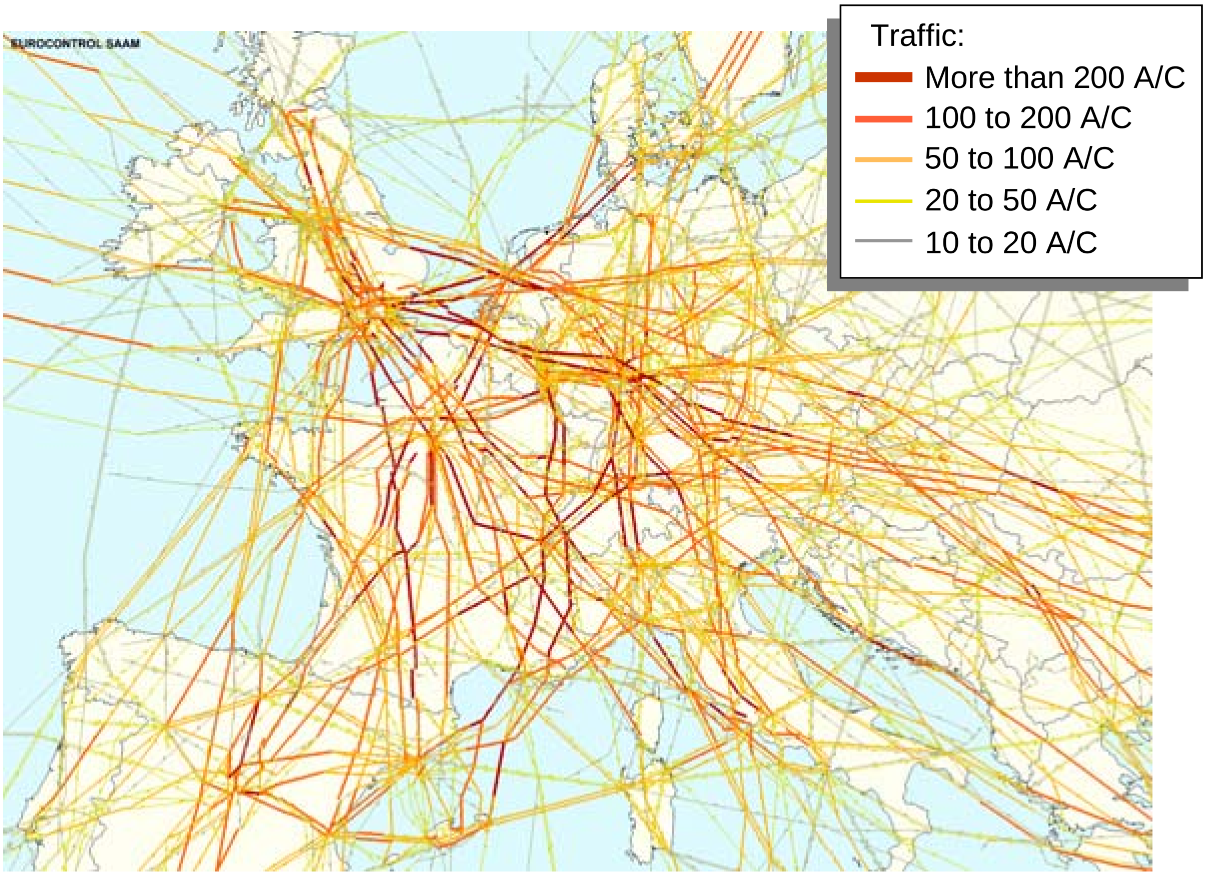

Figure 3 Current daily traffic flows on route network

The number of movements at the key airports within FABEC in 2006 is presented in Table 2.

	Movements in 2006 (x1000)
Paris CDG	520
Frankfurt	488
Amsterdam	434
Munich	408
Zurich	248
Brussels	248

Table 2 Number of movements at major airports in 2006

Based on these figures, FABEC clearly has a crucial role in the European civil air traffic network.

Another aspect to be considered is the military use of available airspace within FABEC. As an example, military training areas in the core area of FABEC airspace are presented in Figure 4.

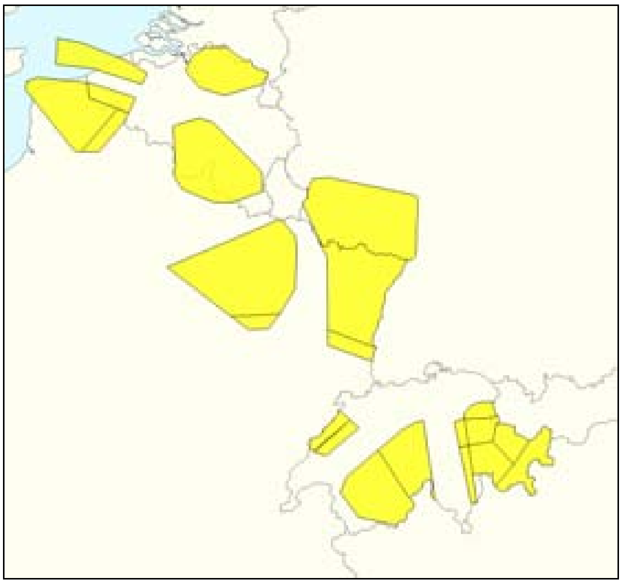

Figure 4 Example of military training areas in core area of Europe

Airspace design is currently carried out according to national boundaries, giving rise to some inconsistencies between the FABEC States, particularly due to varying design principles used by each ANSP. This fragmentation in airspace design is most problematic at the interfaces between adjacent States/ANSPs.

3.2 Civil operations

Civil centres and ATCOs

Civil air traffic in the FABEC region is managed by 13 air traffic control centres. Although all civil ANSPs provide their controllers with operational procedures that are compliant with ICAO, local differences do exist from one ANSP to another and in some cases from one unit to another.

ANSP	Civil units
Belgocontrol	Brussels
LVNL	Amsterdam
DSNA	Brest
	Marseille
	Paris
	Reims
	Bordeaux
DFS	Bremen
	Munich
	Karlsruhe
	Langen
EUROCONTROL	Maastricht
skyguide	Geneva
	Zurich

Table 3 FABEC civil units

All ANSPs provide services in their national airspace, with the exception of some delegations of services (e.g. parts of French airspace are delegated to skyguide, and the airspace of area control services over Luxembourg are provided by Belgocontrol) and the specific function of Maastricht Upper Area Control Centre (MUAC) which provides services in the upper airspace of Belgium, northern Germany, Luxembourg and the Netherlands, operating within the legal framework of a 4-States agreement with EUROCONTROL.

In total, the six civil ANSPs that provide area control services have available approximately 5,500 qualified ATCOs. Ratings for controllers differ between States, and in specific cases, civil or military status of controllers is approached differently. DSNA does not foresee a shortage of controllers in the near future, for the other civil ANSPs this may become an issue.

The Local Convergence and Implementation Plans (LCIPs) for the FABEC States for the years 2008-2012 show that ANSPs are planning to increase the capacity that can be delivered within the airspace. This will be achieved by implementing new systems, technology and procedures, as well as resectorisation of the airspace.

Flow management

In support of the ANSPs the objective of the air traffic flow and capacity management (ATFCM) function is to provide up-to-date flight plan data, maximise the utilisation of available

ATC capacity, smooth traffic loads and to protect against overloading airspace. For aircraft operators the objective of the ATFCM function is to provide input and guidance in support of their flight planning requirements and to minimise delay due to traffic congestion.

ATFCM for the majority of European airspace, including the FABEC area, is coordinated by the Central Flow Management Unit (CFMU), based at EUROCONTROL Headquarters in Brussels. The CFMU coordinates and collaborates with the ANSPs and aircraft operators to provide a complete ATFCM service including flow and capacity planning, coordination and execution.

Aeronautical information services

The aeronautical information services (AIS) within the FABEC area of responsibility are performed by a number of providers located within each State. Internal to each State often civil and military providers are separated, i.e. civil AIS and military AIS. An overview of providers and service units is given in Table 4.

All civilian AIS providers are certified to ISO 9001:2000 and have attained SES certification. There is varied implementation of electronic aeronautical information publication (eAIP) and much of the promulgation of AIS material has been outsourced to external service providers. There are also some differences in procedures design (PANS OPS) across FABEC. In some States this function is located within the AIS structure whereas in others it is located within another structure of the ANSP or military authority. Migration to the European AIS database (EAD) has not been fully completed by many ANSPs or military authorities although most have plans to do so by 2010.

Meteorological services

For the exchange of MET information, various different formats are currently being used in Europe. The majority of the local MET information exchange at airports is not regulated, leading to the use of many different formats. In addition, there are a number of new MET information products being introduced, with localised solutions, and the lack of standardisation is preventing ATM making the optimum use of available MET data.

MET service provision within the FABEC area is performed by a number of MET service provider (METSP) organisations, including one or often two per State: a civil and a military METSP. All current METSPs for international civil aviation are SES certified and designated by their State as per Table 4.

State		AIS service provider	AIS service units	MET service provider
Belgium	CIV	Belgocontrol	centralised AIS, Steenokkerzeel	Belgocontrol
	MIL	Belgian defence	centralised NOF, Semmerzake ATCC, AROs at the airfields	MeteoWing
Germany	CIV	DFS	centralised AIS, Langen	DWD (Deutscher Wetterdienst)
	MIL	AFSBw	NOF and COM centre, Frankfurt, AROs at the airfields	AGeoBw
France	CIV	DSNA - SIA	centralised AIS, Bordeaux	Météo-France
	MIL	DIRCAM - DIA	centralised AIS, Bordeaux	Météo-France and/or Air Force
Luxembourg	CIV		shared with Belgium	Service Météorologique
	MIL		not applicable	not applicable
The Netherlands	CIV	LVNL	centralised AIS, Schiphol	KNMI
	MIL	RNLAF	centralised AIS, Nieuw Milligen	LMG
Switzerland	CIV	skyguide	centralised AIS, Wangen	MeteoSwiss skyguide
	MIL	skyguide	integrated with civil AIS	MeteoSwiss
EUROCONTROL Maastricht UAC		AIS and MET services for MUAC are provided through a number of different arrangements		

Table 4 Current FABEC AIS and MET Provision

Contingency

Currently contingency provisions vary across the FABEC region. The definition of contingency plans in the SES Common Requirements states that: "*an ANSP shall have in place contingency plans for all the services it provides in the case of events which result in significant degradation or interruption of its services*". However the level of services to be provided is not equally provisioned for across the FABEC region (i.e. given a catastrophic failure some partners can only ensure services for a short term whereas others provide for backup facilities that can sustain a higher level of capacity for a longer period).

At present, the contingency plans of the civil ANSPs are mainly nationally based, with little or no 'cross-border' planning for the joint use of contingency resources or for the application of harmonised contingency measures.

3.3 Military operations

Responsibility for service provision to military airspace users differs between States and depends on the institutional model of civil/military cooperation adopted by each State. An overview is provided in Table 5.

State/organisation	Civil/military relation
Netherlands	RNLAF provides ATS services in dedicated military airspace, separately from the civil ATM provision (LVNL).
Germany	German Air Force is responsible for the provision of aerodrome and approach control at military aerodromes only. DFS is responsible for the provision of all ATS services for GAT and OAT except for these military aerodromes. Military area radar controllers and Flight Data personnel are integrated into DFS as DFS employees. A DFS unit is co-located in MUAC.
Maastricht UAC	A DFS unit provides ATS in the northern part of Germany to OAT only.
Belgium	Belgian Defence provides ATS services in dedicated military airspace, separately from the civil ATM provider (Belgocontrol).
France	The organisation and management of French airspace is separated but coordinated between DIRCAM (military) and DSNA (civil).
Switzerland	Service provision to the Swiss Air Force is fully integrated within skyguide.

Table 5 Responsibility for service provision to military

There are no dedicated military control centres in Germany and Switzerland. In Belgium, France and the Netherlands, dedicated military control centres do exist.

3.4 Systems and services

In broad terms, the ATM systems of the civil FABEC partners are different and have been developed to meet the needs of individual ANSPs. In this sense the systems of the FABEC partners are mostly fragmented. Hence they offer an opportunity to reduce this fragmentation by cooperation, as part of the planning phase for new systems.

Significant ATM development programmes are in place at all civil ANSPs over the next five years, in particular in relation to replacement and upgrade of Air Traffic Management/Flight Data Processing (ATM/FDP) systems. Some common sub-systems exist, including ARTAS.

For communications, navigation and surveillance (CNS) infrastructure, there is a multitude of diverse technical sub-systems operated by each partner, although there are some areas of system commonality between two or more partners, notably ILS, other navaids, some secondary radar systems, RAPNET and RMCDE.

Technical support staff accounts for approximately one third of the total workforce of the ANSPs.

3.5 Safety management

Safety management within the FAB currently takes place at a national level with direct interactions between civil ANSPs and their corresponding National Supervisory Authority (NSA).

There are commonalities in what the ANSPs are required to do in respect of safety management. This is as a result of regulations such as the Single European Sky Common Requirements and also the Safety Regulation Commission's EUROCONTROL Safety Regulation Requirements (ESARRs). However, within the ANSPs, safety activities at the national level are still organised in a variety of configurations with differences in organisation, policies, procedures and resources.

Where there are trans-national projects in technology or operations, safety is typically addressed in an ad-hoc manner as suits the particular project, bilaterally between the participating NSAs. Clearly MUAC represents a rather unique example whereby it is overseen by the four participating States.

3.6 Financial situation

The FABEC civil ANSPs had aggregate ANS revenues in 2006 of €2911 m[1]. However, this is an overstatement of the revenue to FABEC from providing en-route and terminal ANS, since there are some payments between the ANSPs: DSNA collects revenue from airspace users in French airspace which is controlled from Geneva, but this revenue also appears as revenue for skyguide (through a payment from DSNA to skyguide). A similar situation exists between Belgocontrol, DFS, LVNL and MUAC. Correcting for this, the total ANS revenue of the FABEC is estimated as €2876m.

Nearly 80% of this revenue is earned through provision of en-route services, and just over 20% through terminal services. The vast bulk of en-route revenue (95%) comes from en-route charges; most of the rest comprises payments from domestic governments in respect of exemptions.

The aggregate costs of the FABEC ANSPs amounted to €3005m. This again is an overstatement of the costs of FABEC as one of the costs of certain ANSPs is the payments made to other ANSPs (MUAC and skyguide) for delegated airspace. Again correcting for these payments gives a total FABEC cost of €2861m.

Of these costs, around 80% are attributed to en-route services and 20% to terminal services.

The ANSPs' costs are made up as follows[2]:

▪ costs of ATM/CNS provision	€2520m	88%
▪ MET costs	€140m	5%
▪ EUROCONTROL HQ costs	€184m	6%

The first category comprises those costs deemed by the Performance Review Unit (PRU) to be 'directly controllable' by the ANSPs. The costs of ATM/CNS provision can be further divided into:

▪ Employment costs for ANSP staff	64.7%
▪ Non-staff operating costs	16.3%
▪ Depreciation costs	14.3%
▪ Cost of capital[3]	4.6%
▪ Exceptional items	0.1%

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[1] These are the 'gate-to-gate' revenues quoted in the PRU ACE report. They comprise revenues for en-route ANS and terminal ANS, but exclude 'other ANS' in the PRU's terminology, the major component of which is services to military OAT.

[2] Some other categories of costs, such as irrecoverable value-added tax and payments to governments, amount to less than 0.5%.

[3] Calculated according to the definitions of the EUROCONTROL Route Charges System

The net fixed assets of the FABEC ANSPs have a book value of €1918m. Working capital and provisions amount to €402m.

3.7 Charging

In the feasibility study, attention was limited to en-route charges only.

All FABEC States currently use the option of ‘full cost recovery’, in which en-route charges are set to recover all the costs deemed by the Member State to be associated with providing the service in the charging zone. The set of costs that may be recovered is called the ‘en-route cost base’. Traffic is expressed in ‘chargeable service units[4]’. The expected future cost base is divided by the expected estimate future number of service units to give the ‘unit rate’.

The system in the FABEC Member States is currently administered by the EUROCONTROL Central Route Charges Office (CRCO). At present, four of the six FABEC states prepare submissions to CRCO concerning costs, traffic and unit rates relating to charging zones that cover their national airspace. A fifth submission relates to Belgium and Luxembourg (one charging zone).

The current, past and projected future unit rates of the FABEC states are shown in Figure 5. For comparison, 2008 rates for some of FABEC’s neighbours are also included.

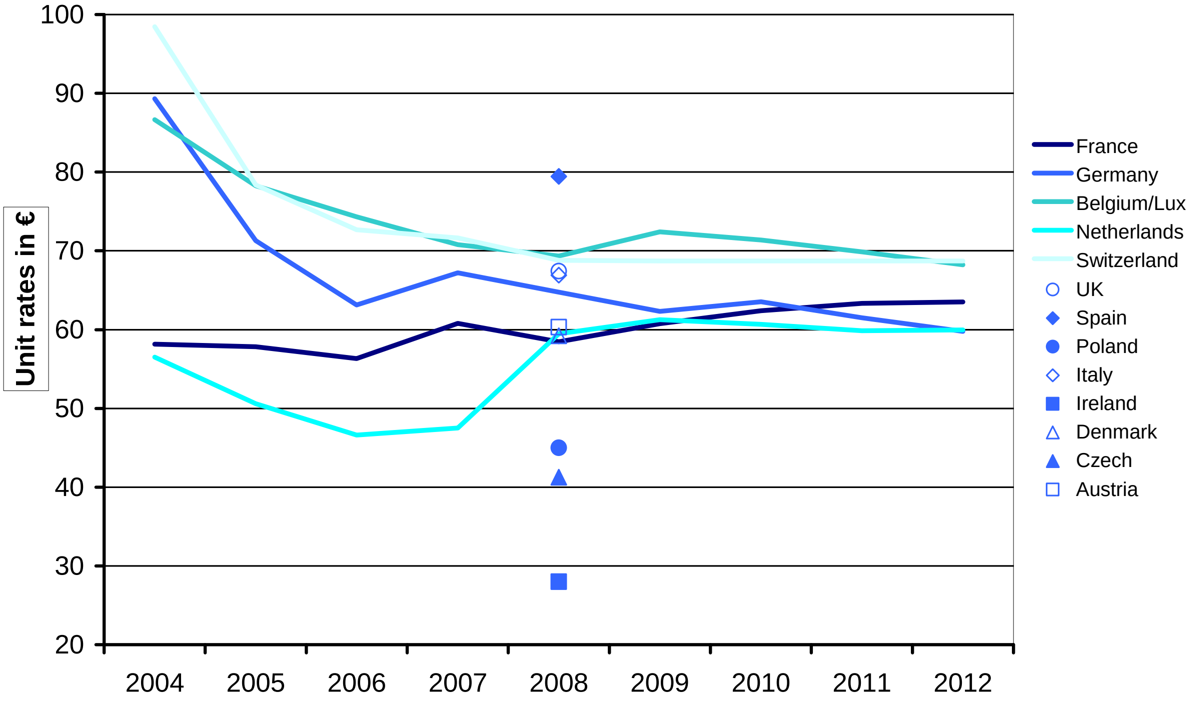

Figure 5 Historic, current and projected unit rates in FABEC States

There are marked disparities in the unit rates, although, as the illustrations in the graph show, they are relatively small compared to some outside FABEC. Some of the abrupt changes seen in the historic figures result from changes in definitions and traffic evolution.

[4] Service units are based on a combination of distance travelled in the charging zone and weight of the aircraft.

The disparities between FABEC States are projected to diminish over time. They arise from a wide range of causes: differences in what is included in and excluded from the cost base, and the boundary between en-route and terminal services, as well as differences in circumstances. They should not be used to infer any conclusions about the effectiveness of individual ANSPs.

3.8 Training

3.8.1 Civil ATCO training

For all civil 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. 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 harmonised than initial training.

All 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 all ANSPs for licensed functions: On-the-job training instructor (OJT-I), assessor (ASS), examiner (EXM), supervisor (SUP).

Initial training instructors are typically operational or retired ATCOs, but exceptions exist in one ANSP. At the unit training stage, OJT-Is are operational ATCOs or recently retired ATCOs.

Tools used include radar simulators, tower simulators and computer based training (CBT) programmes.

3.8.2 Civil/military cooperation in ATCO training

Civil/military cooperation on ATCO training differs greatly. This is partly due to the different civil/military cooperation models in use across the FABEC States and because ATS provision for general air traffic (GAT) and operational air traffic (OAT) is distributed differently between civil and military ATCOs in these States (see also Table 5).

The military ATC providers in the Netherlands, Belgium and France have their own training facilities. In Germany the military provider has its own facilities but area control training is provided by DFS, whilst in Switzerland training is provided by the civil provider. Military training is compliant with ESARR 5, except within France. There are language differences (only Belgian and German military and skyguide train in English) and additional requirements for the different military training.

3.8.3 ATSEP training

For ATSEPs (air traffic services engineering personnel), training consists of the phases of initial training, system/equipment rating training, continuation training and development training.

Although ANSPs have theoretical and practical training, the current initial training content varies between ANSPs. Extra courses are provided at basic training level by some ANSPs, including meteorology, ATC simulations, flight simulation, safety awareness and project management.

System/equipment rating training is the final phase before qualification, which needs to meet the expanded requirements of ESARR5. Rating training is usually provided by the ANSP, the unit and in some cases the manufacturer.

The content of continuation training can be refresher training, practical or theoretical training and assessments/exams. Development training is provided according to need and level-rated tasks, with no formal or specific training.

3.9 Institutional and regulatory situation

The different States of FABEC are governed by international regulations, covering ICAO, EC and, where applicable, national civil and military regulatory issues. National regulatory structures define the responsible organisations, their roles, legal basis, performance of oversight and how liabilities are attributed between the various State bodies.

There are differences between organisations, but no significant impediments to international cooperation (although this partly depends on the level of cooperation that is foreseen). Differences of civil ANSPs are apparent in governance structures, ownership, goals and objectives, permissible ventures, board appointments, funding and financing. Correspondence with international legal frameworks has led the States to similar structures, roles and responsibilities. Typical differences lie in:

- The legal form of ANSPs, from State to private bodies
- How liability is passed between organisations and indemnified
- How military ATS is carried out
- How designation has been carried out
- The method of delegation and use of Letters of Agreement
- Decision making and consultation methods, such as for determining terminal and en-route charges
- The legal levels adopted for implementing rules and regulations (i.e. where primary, secondary legislation and rule making is used)
- The joint civil/military organisation and implementation of airspace design and management including the flexible use of airspace
- Responsible organisations for safety, economic and airspace regulation

In a more general sense, the type of differences apparent between States and ANSPs concern the levels of approval required in implementing agreements and the progress in implementing new standards and regulations, including the establishment of new bodies.

The institutional arrangements for civil/military cooperation differ between States and range from segregated to integrated organisations. Between the extremes of segregated and single organisations, there are different intermediate forms of cooperative ATM, which extend from ad-hoc cooperation to performing ATM in a single building or out of a common control room.

4 Improving on the current situation

Traffic demand is expected to continue to grow over the next years which will lead to enhanced requirements in terms of safety and capacity. At the same time, there are calls for reduction of cost of service provision and reduction of impact of air traffic on the environment. In the current situation, with ANS provision fragmented through organisation at a national level, this puts forward considerable challenges which can not be countered only on national level.

From the ‘current situation’ and near term plans, several factors can be identified that set the tone for air navigation service provision in the next few years: traffic demand will continue to grow, airspace users are calling for increased cost effectiveness, the environmental impact of air traffic will remain a subject of high interest, and above all, safety levels must be maintained or increased. The ‘current situation’ will need to develop over the next few years into a future situation which addresses these factors and other issues.

4.1 Reducing fragmentation in ATM

Organisation of ANS at the national level has resulted in fragmentation in European ATM. Fragmentation reduces cost effectiveness and can have an adverse impact on capacity, quality of service and safety, and therefore should be a high priority in addressing the issues with the current situation. The Performance Review Commission study into the impact of fragmentation ([Ref. 10]) estimated that in Europe the annual costs of fragmentation were around €0.8 billion - €1.5 billion, some 20-30% of annual en-route costs.

Components contributing to these costs cover many areas: fragmented operational concepts and airspace design around national borders, the diverse ATM systems in use (leading to a lack of system interoperability, piecemeal procurement and sub-optimal maintenance and development) and the duplication of associated support and administrative functions.

A number of these components apply in the FABEC region: sector design is constrained by national boundaries, although there may be some delegation of responsibility for ATS in cross-border airspace; procurement of technical infrastructure is done individually by ANSPs; to a large extent the maintenance of ATM systems and CNS is organised on an individual basis by each ANSP.

There are examples where cooperation is already in place, in particular in the technical area: radar data sharing and joint specification of surveillance data processing systems. There is considerable scope for efficiencies to be made through more in-depth cooperation and collaborative initiatives in all areas to exploit economies of scale and reduce fragmentation. It should be noted though that defragmentation is an enabler to improve cost effectiveness, capacity, etc., and may be pursued in areas where it can deliver benefits, but reducing fragmentation is not a goal in itself.

4.2 Maintaining safety with growing traffic levels

The first priority for managing air traffic is safety. Traffic levels across the FAB are expected to grow significantly and the ANSPs are seeking to provide sufficient capacity to address this. Underpinning the future operation is the need to ensure that today's safety levels are achieved or improved upon, even with more flight operations.

This will be achieved through airspace design and procedures that will be designed to handle more traffic whilst maintaining safety. Advanced controller tools will help deliver safety and thus accomodate a higher traffic volume. This will subsequently be assured through a consistent application and review of safety analyses and studies before any of the changes will be put into operation.

Best practices in safety management and safety assessment technologies should be applied as widely as possible. A contributor can be to address inherent risks in the current operation that arise at the interface between States. Furthermore, tighter integration of safety management activities in different States will ensure harmonisation of safety activities with commensurate opportunities for learning and sharing of experience.

4.3 Providing capacity to meet demand

The capacity of en-route airspace is a measure of the amount of air traffic that can be handled within a given area of airspace, whilst generating an acceptable level of ATFM (Air Traffic Flow Management) delay.

The EUROCONTROL Performance Review Report 2007 ([Ref. 11]) noted that for Europe as a whole: "*Since 2004, the provision of capacity has been lagging behind traffic growth again, resulting in a continuous increase in en-route ATFM delays between 2004 and 2007.*"

Analysis carried out for the feasibility study has estimated that even with the capacity increases foreseen by the ANSPs the average ATFM delay per flight is expected to rise from 0.7 minutes per flight in 2006 to approximately 2.5 minutes per flight in 2020, rising further to approximately 3.5 minutes per flight in 2025. ANSPs within the FABEC region will need to increase the capacity provided to overcome the capacity gap that has been identified.

The PRR2007 report has also noted that local measures to improve capacity in some core areas of Europe (including some areas of FABEC) may not be sufficient to achieve optimal performance at network level. Regarding ACCs in high density areas where delays are occurring, the report says:

"*Most of these ACCs are already operating at high productivity levels. In the core area, local measures to increase capacity might not be sufficient to reach an optimum at network level.*"

Optimising performance of the European ATM network will require coordinated actions between neighbouring ANSPs in the core area in the short and medium term. PRR2007 concludes that: "*In the core area, local measures to increase capacity might not be sufficient, and it is probably most efficient to plan and implement coordinated actions in the short/medium term (improved cooperation at European network level: FUA, DMEAN, FABs, etc). Moreover, it is important to ensure that SESAR develops solutions to meet capacity requirements in the longer term.*"

This conclusion of the Performance Review Commission underlines the key contribution that FABs, and related activities such as Flexible Use of Airspace, can have to increasing capacity and improving the overall performance of the European ATM network.

4.4 Addressing flight efficiency constraints

Flight efficiency measures the difference between the optimum trajectory and the actual trajectory flown for a given flight. Deviations from the optimum trajectory generate inefficiency in terms of time, fuel burnt and cost to airspace users, and have a direct impact on the environment. Whilst optimising flight efficiency is desirable, trade-offs between flight efficiency and other key performance areas such as delay and capacity have to be considered in assessing how far flight efficiency can be improved - in particular cases users may prefer a less efficient route avoiding areas of limited capacity and high delays.

En-route flight efficiency is comprised of two components: horizontal and vertical flight efficiency. Horizontal flight efficiency is well understood within the ATM community. It measures the excess kilometres flown by a flight between terminal exit and entry points compared to the optimum route. Vertical flight efficiency is less well understood and relies on a large number of variables such as aircraft type and weight, and meteorological conditions. In addition, an optimum vertical trajectory can be considerably different even for the same aircraft type. Therefore, focus here is on horizontal flight efficiency.

Horizontal flight efficiency is constrained by a number of factors, including:

- The design of the route network
- The geographical position of military training areas within the FABEC region
- Aircraft operators filing sub-optimal flight plans to avoid:
  - Congested areas
  - States where route charges are more expensive

In 2006 in is estimated that each flight travelled an additional 53km. By 2018 it is estimated that flight efficiency will worsen, with each flight travelling an additional 64km in 2018. The main causes are an increased requirement for military training areas, and the increased delay situation which may lead aircraft operators to re-file flight plans to avoid congested regions of airspace (to avoid costly ATFM delays).

PRR2007 identified Switzerland, Belgium, Germany and France within the six FABEC States with the highest values for route extension per flight. PRR2007 also noted that the five largest States in Europe (which include Germany and France) account for 63% of excess kilometres flown, which is greater than their share of the traffic (55%), and quote that: "*Furthermore, most of the route extension is under the direct control of those larger States, who therefore bear a special responsibility in ensuring that the European target is met.*"

Whereas this indicates that flight efficiency can be improved by the larger States through measures at a national level, the impact of any measures will increase by applying them to the wider geographical scale of the FAB.

4.5 Impact on the environment

Climate change has been high on the international political agenda in recent years, with the contribution of the aviation industry being of particular interest. According to the European Environment Agency aviation contributes approximately 3% of greenhouse gas emissions in Europe. Between 1990 and 2005 greenhouse gas emissions decreased in all other sectors except transport, where they increased significantly. Taking into account the reduction in emissions in other sectors and the predicted increase of aviation the relative contribution of air transport to overall greenhouse gas emissions is likely to increase.

For each 1kg of jet fuel that is burnt, 3.15kg of CO_2 is emitted. Therefore, any reduction in fuel burn will result in a proportional reduction of CO_2 emitted. Hence, improving flight efficiency can play a part in reducing the amount of CO_2 emitted by aircraft.

4.6 Cost effectiveness of ATM provision

Analysis within the feasibility study shows that with the implementation of currently planned initiatives of the ANSPs, financial cost effectiveness is expected to improve. Over the next 10 years, this should lead to a reduction of the cost of service provision per flight hour of about 15%. However, two issues need to be considered. Firstly, the improvement in cost effectiveness is expected to stabilise after 2018 with little or no further improvement, unless other initiatives are taken. Secondly, and more importantly, over the same period the quality of service that can be provided is expected to decrease. As described in previous sections, demand is set to outgrow capacity, leading to increased delays and reduced flight efficiency.

The estimated cost of delays and flight inefficiency to airspace users may be integrated into the 'economic cost effectiveness' of service provision, rather than the 'financial cost effectiveness' which only considers the cost and not the quality of the service. It is clear that, to truly deliver improved cost effectiveness to users, in combination with pursuing opportunities for cost reductions in service provision, the issues of capacity and flight efficiency need to be addressed.

SECTION III: FINDINGS OF THE STUDY

5 Improvement through cooperation

Taking into account civil and military needs where applicable, the feasibility study has identified a number of opportunities for cooperation, which together will increase the overall performance. Therefore cooperative initiatives have been defined in the areas of operational concept, airspace design, technical infrastructure, safety management, charging and training. Further opportunities exist in the areas of AIS, MET and contingency.

From the description of the current situation and the analysis of the issues facing ATM in the next years, it is clear that much can be gained through cooperation beyond the traditional, national boundaries. This forms the basis of the FAB Europe Central initiative.

The feasibility study firstly identified areas in which cooperation at FAB level is likely to bring improvements and secondly investigated the means to deliver those improvements. This section describes the improvements proposed and the changes envisaged through FABEC cooperation. The improvements cover a range of subjects across the whole spectrum of provision of air navigation services, from operational and technical aspects to issues of safety, charging and training.

At the core of the feasibility study has been the assumption that a functional airspace block is an operational issue, and the objective of cooperation will be to enable the related operational concept and airspace design, and to unlock the benefits it can bring. This does not diminish the benefits arising from cooperation in other areas, but rather ensures that actions will be strongly aligned in delivering the operational and business improvements. Through increasing operational convergence, the study participants expect further cooperation to be achievable, notably through harmonisation, e.g. in terms of maintenance of technical systems, training, etc. Eventually, the airspace of the different States should appear to be one continuum to the users, in line with, and perhaps exceeding, the objectives of the Single European Sky.

5.1 Addressing the main issues: the added value of cooperation

In the previous section, some key issues with the current situation were identified that put pressure on the operations of airspace users today or in the near future. These issues can be addressed through cooperation within FAB Europe Central:

- Through organisation of airspace and air traffic management irrespective of national borders and coordinated between civil and military partners, flight efficiency can be increased as:
  - The route network is optimised for a wide area
  - Focus on FAB level flow and capacity management reduces re-routing around congested areas
  - Common charging reduces re-routing around areas with high charges

- Increases in flight efficiency in turn lead to a reduction in fuel burnt and hence in emissions per flight.
- Capacity is also increased through the better organisation of airspace and air traffic management, both directly through the more efficient use of available space, and indirectly through optimised positioning of interfaces leading to better distribution of workload over the airspace.
- A common operational concept will assist ATCOs in achieving high performance and delivering increased capacity.
- A coordinated approach, using a common technical roadmap, for the implementation of technical [sub-]systems that are required to support the operational concept, will lead to improvements in safety and cost effectiveness.
- A coordinated approach on the planning, specification, procurement, development and maintenance of common technical [sub-]systems will lead to improvements in safety and cost effectiveness.
- Increased cooperation between civil and military partners further enhances efficient use of the airspace in terms of flight efficiency and capacity.
- A cooperative approach to safety management will be a significant enabler towards providing high levels of safety in FABEC.
- Harmonisation in operational and technical areas will enable further cooperation in the organisation of training, leading to additional improvements in cost effectiveness. In return, training defined in common and at FAB level will allow full benefits of operational and technical initiatives to be gained.
- In combination, all of these opportunities will reduce fragmentation in the FABEC area.

In the remaining parts of this section, further detail is provided on the initiatives that are proposed to achieve the above.

5.2 Common operational concept

Establishing a common operational concept is one of the main drivers for the establishment of FAB Europe Central. A common operational concept was defined between all ANSPs, civil and military, based on the entire FABEC region as one continuum of airspace. The concept will contribute to meeting the needs of airspace users by delivering increased capacity and flight efficiency, through common information sharing and decision making and a harmonised working methodology. Indirectly, this will also contribute to improving safety and reducing environmental impact.

The concept addresses all phases of operation from strategic planning to tactical execution, aiming to provide a comprehensive service and accommodate all stakeholders. At the same time, the concept will provide the flexibility for service provision to adapt to specific local requirements. Furthermore, it identifies future roles and responsibilities of the various operational actors contained within the concept and functions.

The common operational concept incorporates existing views on future concepts of the different ANSPs, as well as international organisations such ICAO and EUROCONTROL and developments in the SESAR definition phase.

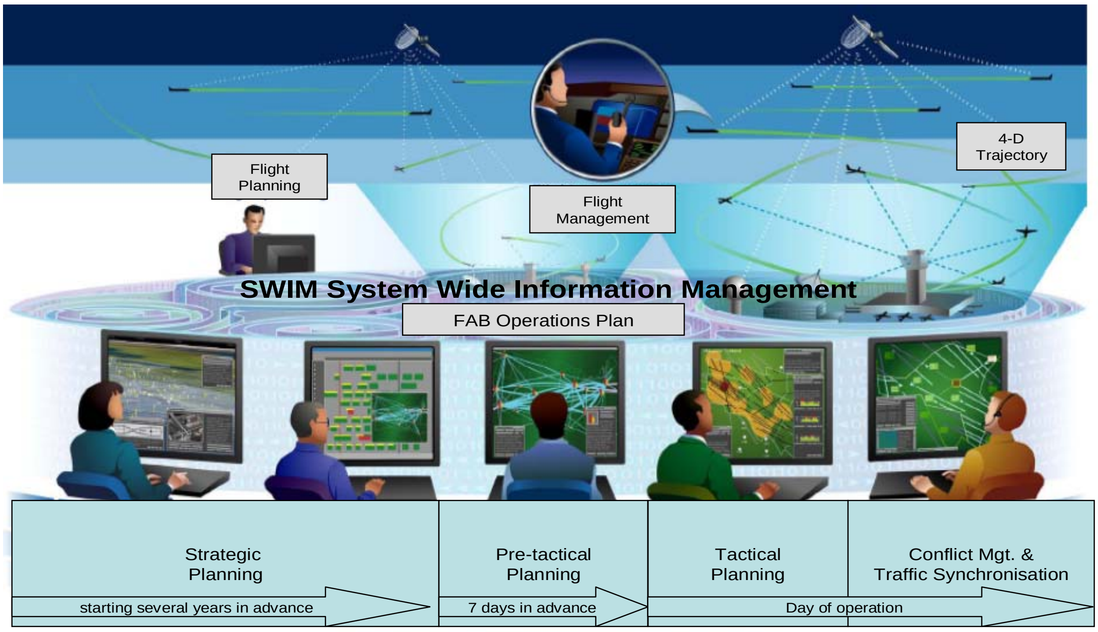

Figure 6 The overall context of the operational concept

The development of the operational concept set out to focus on the globally accepted ICAO ATM components and apply them to all relevant operations within the FAB. The ATM components as recognised by ICAO are: airspace organisation and management, aerodrome operations, demand and capacity balancing, traffic synchronisation, conflict management, airspace user operations, and ATM service delivery management.

Based on these ATM components, four main building blocks were identified for the FAB concept:

- Common information management (as part of ATM service delivery management)
- Airspace organisation and management
- Demand and capacity balancing (through air traffic flow and capacity management)
- Air traffic control (covering the components of traffic synchronisation and conflict management)

The remaining two components, aerodrome operations and airspace user operations, have been taken into account during the development phase of the concept, e.g. through their links to information sharing and traffic synchronisation, but are not part of the main focus of the defined concept.

5.2.1 The building blocks of the operational concept

Common information management

Information sharing is a prerequisite for the optimal provision of air traffic flow and capacity management, airspace management (ASM) and ATS within the FAB. By promoting seamless information exchange from the Area Control Centre (ACC) level to the FAB level, an up-to-date consolidated demand and capacity overview of the FAB ATM network can be created. Through the timely availability of information, the network can be organised to enable all airspace users to operate safely and cost effectively in a European airspace organisation optimised for any given scenario on any given day.

The exchange of information covers the following areas:

- From the flight planning perspective, achieving optimal organisation of operations requires definition and management of 4D trajectories, with both airspace users and ATC providers having a role in achieving the agreed trajectories.
- System wide information management (SWIM) enables each ATM partner involved to create an integrated picture of the past, present and (planned) future ATM situation and organise their operations as appropriate within this picture - whilst also updating the system of decisions taken so that users maintain an accurate picture.
- Improved weather forecasting and information sharing can assist in reducing the considerable impact on operations that poor weather brings.
- The FAB Operations Plan is separate from but linked to and consistent with the ECAC-wide Network Operations Plan (NOP). The FAB Operations Plan provides a higher level of real-time detail for the FAB partners and will be continually accessible and updated during strategic, pre-tactical and tactical phases by ATM partners.

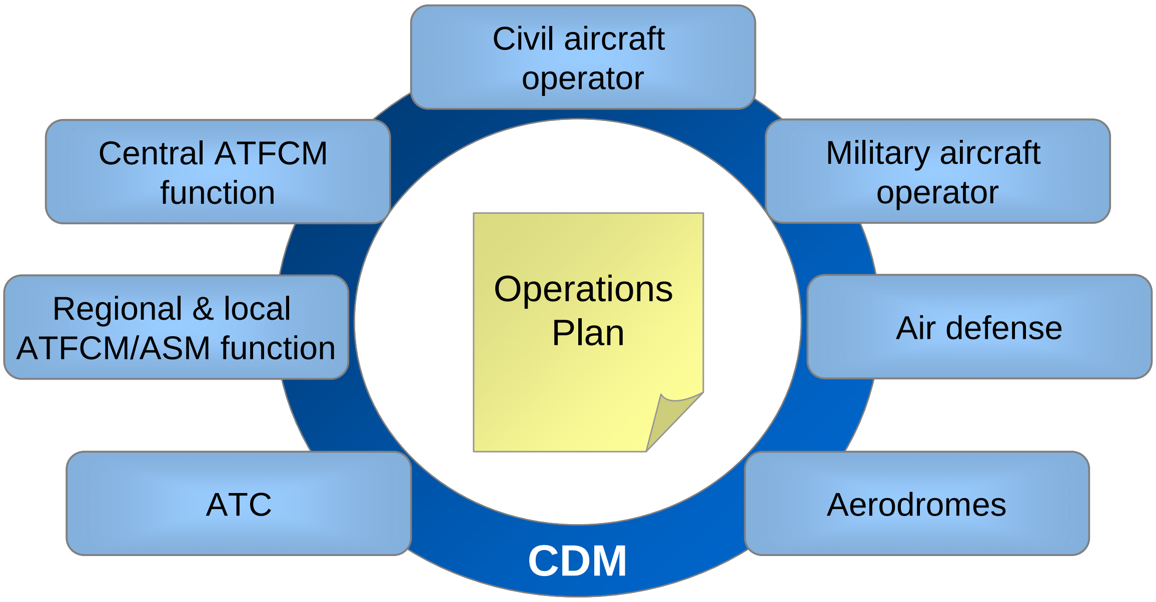

Figure 7 FAB operations plan

With common information sharing in place, decision making processes all become part of the overall FAB process as if they were part of a single control centre.

Airspace organisation and management

Airspace within the entire FAB will be designed regardless of national boundaries to fulfil civil and military user requirements in terms of flight efficiency, capacity and mission effectiveness. Innovative airspace design and ASM procedures will be applied to make the most efficient use of the available airspace.

The operational concept proposes various airspace organisational and management elements, in particular in relation to the implementation of enhanced flexible use of airspace (FUA) level 1 procedures and the design of the route system.

The implementation of enhanced FUA procedures on level 1 will be achieved through:

- Establishment of military training areas that are designed and located regardless of the national boundaries of the FAB partners
- Creation of modular and dynamic areas
- The support of cross-border areas between FABs

A decision making function at policy level is required to enable the implementation.

The route system will be designed with the aim to offer more route options and a greater freedom in profile selection. Cross-border sectorisation will be applied as appropriate to meet the needs of the traffic flows. The revised route structure will continue to provide connectivity with major TMAs. The route structure will be modelled on a multiple choice route network with pre-determined direct route segments, with planned alternatives, and co-existing with temporary airspace structures.

Implementation of ‘tailored route’ operations in parts of the airspace is foreseen. In this airspace, users will be able to plan their own preferred trajectory (subject to any overriding airspace restrictions) within a known environment and with links to the structured routes at both ends. Such operations are mainly foreseen in higher levels of upper airspace and during night hours (see Section 5.4.2 for more details) and will greatly improve flight efficiency.

Demand and capacity balancing

The concept addresses the ATM component of demand and capacity balancing. The objective is to make best use of the overall ATM capacity in the FABEC area, free potential (latent) capacity and constrain demand only in exceptional circumstances.

To achieve this, the concept includes operations from strategic planning to the day of operations in a seamless and continuous manner. Resource planning, sector design and configuration management are key elements.

Flexible, traffic-orientated sector configuration management (SCM) based on modular sector design and/or sector configurations (see Figure 8) is part of the concept. It will balance demand and capacity by adjusting capacity to that required throughout the FAB airspace. Sector configuration management has a number of basic principles: sectors are designed irrespective of national boundaries or division flight levels; management is to be based on traffic flows and workload; and human resource constraints will be integrated into the exchange of sectors/airspace volumes between ATC units. Sector configuration management provides a step towards the use of ‘dynamic sectors’.

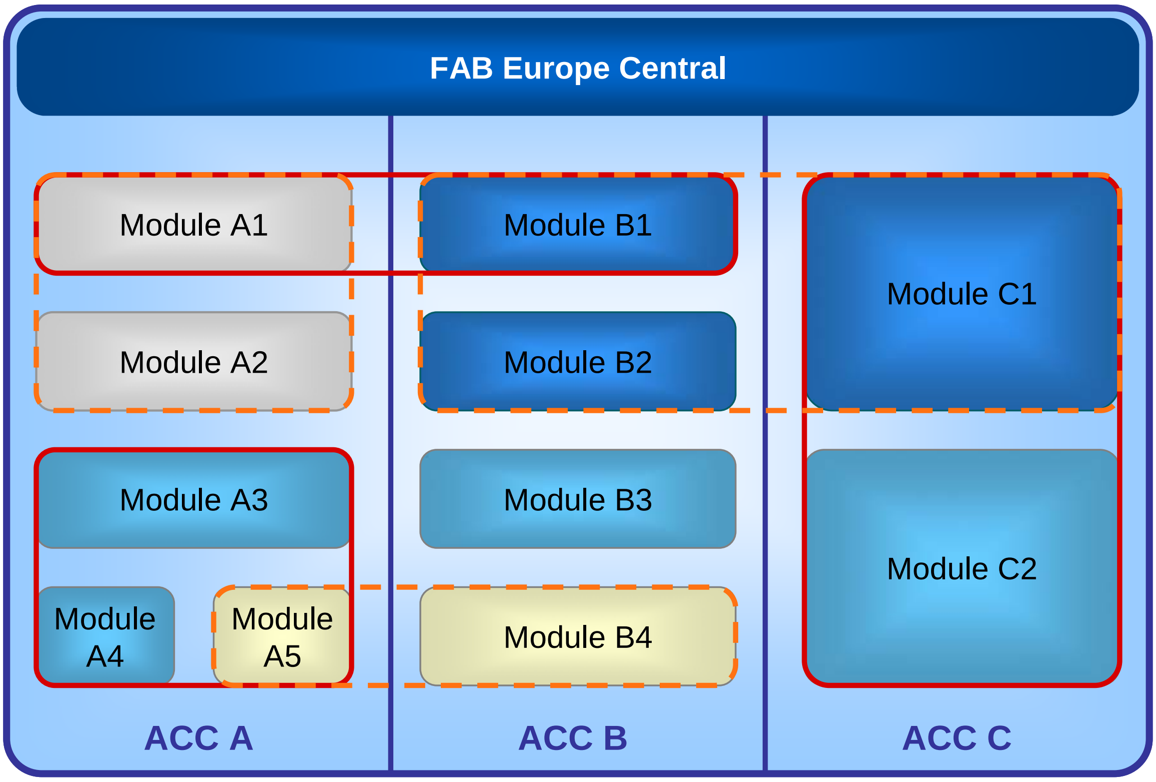

Figure 8 Modular design illustration

<u>Air traffic control</u>

Air traffic control will not change fundamentally but will move from a reactive function to a more pro-active planning function. ATC will continue to be an important element of ATM to guarantee the safety of the services provided.

The human element will remain paramount in the ATM system of the foreseeable future, but the focus of the controller will change slowly with the availability of new technology. New tools will permit earlier detection and resolution of potential conflicts, which will enable the controller to take earlier action, leading to less radical trajectory changes for the aircraft.

The future automated system will contribute to maintaining the operator within a 'comfort window', avoiding both overload and complacency, which are frequently identified as the main contributors to hazardous traffic situations.

In the medium term, new computer-based support tools and new systems, such as 4D trajectory prediction and monitoring aids, will progressively contribute to a change in the nature of ATM. Tools will only be implemented if they decrease workload or enable capacity gains without increasing workload.

Further elements are the reduction of the radio telephony frequency load through data link transmissions and the achievement of a seamless exchange of information through an increased level of interoperability of relevant systems.

In the longer term ATC will comprise traffic synchronisation, arrival and departure management (moved to preventive control with the extending horizon of traffic synchronisation, and maximum airport throughput and increased predictability) and conflict management. With respect to the latter, conflict resolution will move from tactical ATC to pre-tactical and strategic conflict management supported by traffic prediction and medium term conflict detection tools. Automated support for conflict detection will become essential to support a free/tailored route environment.

5.2.2 The ATFCM/ASM function

The ATFCM/ASM function, combining ATFCM and ASM into a single function, is a major part of implementing the operational concept and delivering the benefits of FAB cooperation to all airspace users. Combining ATFCM and ASM into one function is a logical step and in line with EUROCONTROL's future vision of moving from managing demand towards managing capacity *and* demand, and in particular is in line with the DMEAN (Dynamic Management of the European Airspace Network) programme's objectives and framework.

The foreseen FAB ATFCM/ASM function provides flow management and airspace management services at the FAB level. It coordinates and optimises FAB-wide capacity provision, the traffic flows and the use of airspace (e.g. activation of military training areas).

The FAB level ATFCM/ASM function will follow various phases of granularity leading to the day of operations. The main differences between the ATFCM phases (strategic, pre-tactical and tactical) are the number and the roles and responsibilities of partners (see Figure 9) involved in the Collaborative Decision Making process in each of the respective phases, the time given to do it and the need for advance notice of the decision taken.

Overall this phased approach ensures that capacity issues are taken into consideration in the design, placement and activation times of special use airspace.

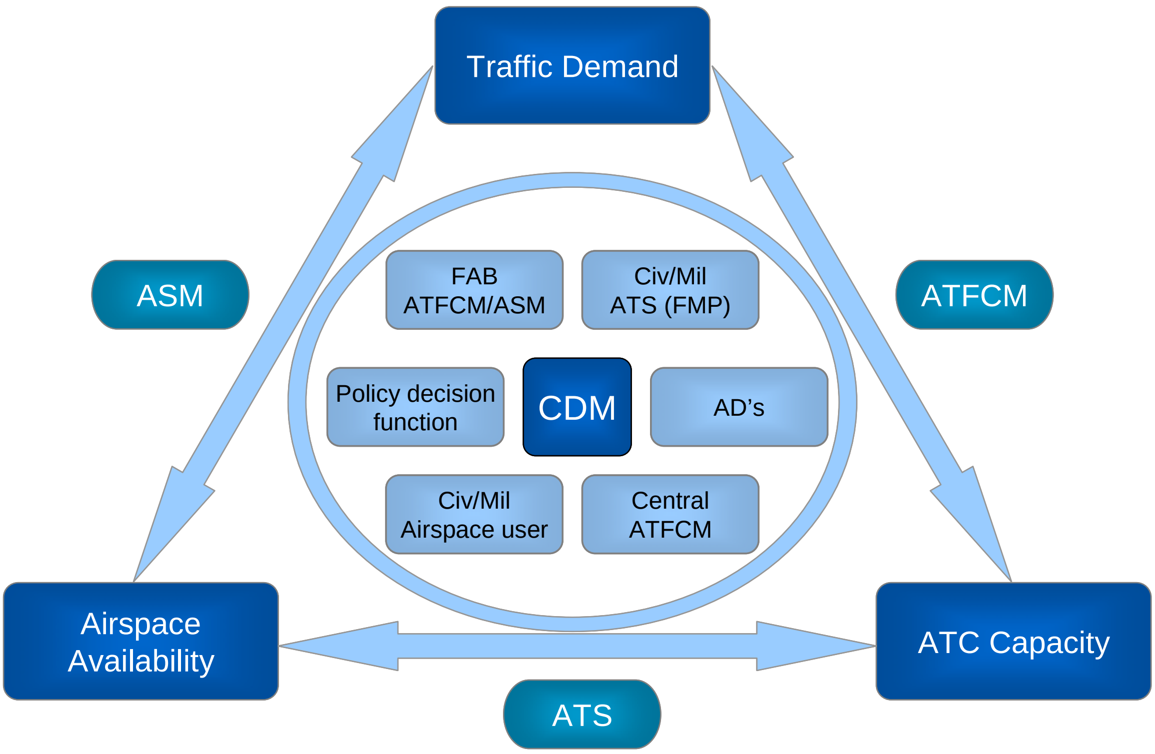

Figure 9 FAB partners in demand and capacity balancing

At all times during these phases the ECAC-wide view from the central ATFCM function is included in the process. This is vital to ensure that competing demands for capacity versus reservations of special use airspace, and their respective scenarios, are balanced and coordinated with the ECAC-wide network.

The central ATFCM function and the FAB ATFCM/ASM function will operate in close coordination. The FAB function will manage at a higher level of detail and will have more responsibilities regarding the management of the FAB ACCs. Basis for the decision making is the FAB operations plan which provides a set of scenarios that can be implemented depending on the events taking place in real time. The FAB operations plan is consistent with the European network operations plan.

The ATFCM/ASM function will require a well established information sharing network between all relevant partners to ensure solutions are coordinated and communicated. This will lead to stability, enabling each actor to optimise their operation in reaction to changes, and maintain overall capacity optimisation.

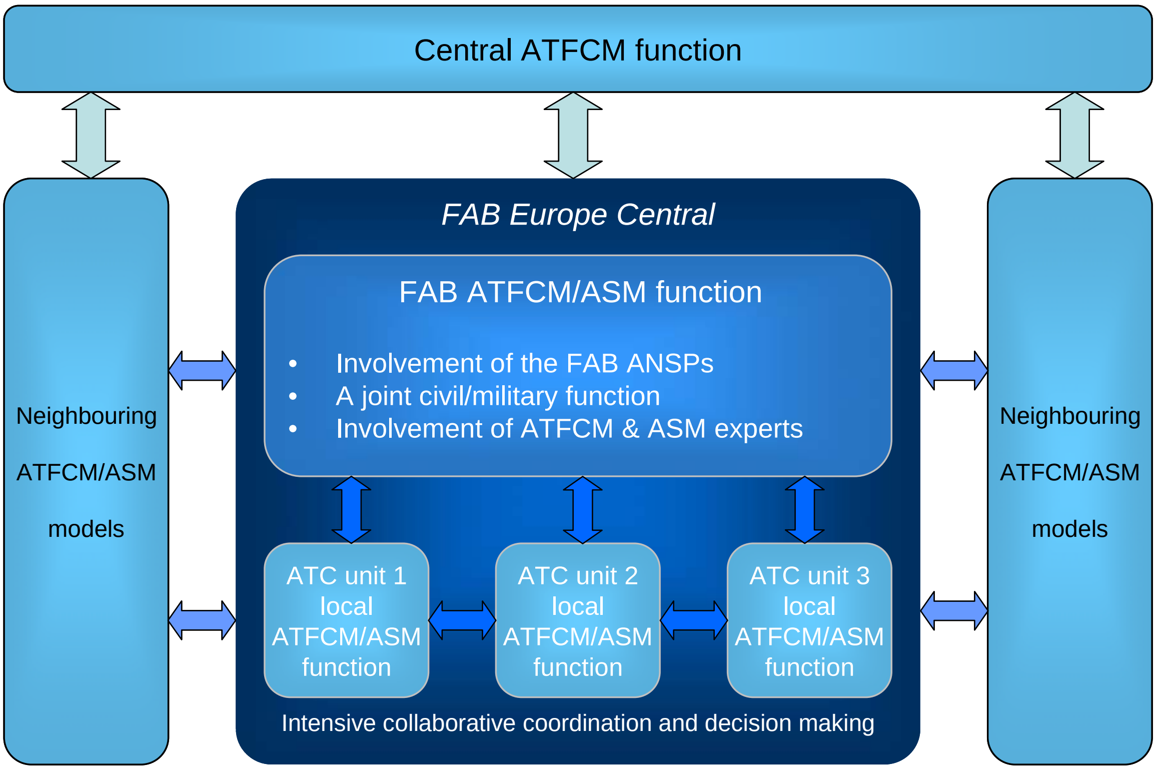

Figure 10 FAB ATFCM/ASM function

5.2.3 Policy decision function

A number of decisions will need to be made at policy level during implementation and operation of the concept. The details of the organisation of the related function are still to be decided.

The main tasks foreseen within this function from an operational point of view are:

- To define and verify that the regulatory framework for ASM, ATFCM and ATS is correctly applied
- To impose procedures in case the regulatory framework can not be applied to a specific situation

- To formulate the national ASM policy and carry out the necessary strategic planning work.

The function will require involvement from States and ANSPs, and from both civil and military partners.

5.2.4 Implementation plan

An implementation plan has been developed for the common operational concept. In this plan, the implementation is sub-divided into manageable so-called 'main implementation packages' (MIPs).

The implementation plan concentrates on the added values of the FAB. This means that the plan mainly indicates, what could be done in addition to the ongoing initiatives on a European (e.g. DMEAN, SESAR) or local level.

The plan identifies three major phases in implementation of the overall concept, in 2009, 2013 and 2018. In most cases, individual packages will also be implemented in two or three steps. The implementation dates refer to the initial implementation; this could be either initial operational capability and/or implementation at first ANSP/location/site(s).

The implementation plan has been integrated with relevant outputs in other areas, in particular technical systems and services. The common roadmap is discussed in more detail in Section 7.

5.3 Airspace design at FAB level

The benefits of designing the FABEC airspace as a continuum are various and can contribute significantly to the performance of the FAB. Examples of such benefits are:

- Applying a single, consistent strategy for airspace design across a wide area leads to a more optimal route structure for the airspace users.
- By designing sectors irrespective of national borders, handover points can be placed in less critical areas, increasing controller productivity.
- More options for placing miliary training areas at locations optimal for both civil and military users can be commonly developed.

The work on airspace design in the context of the feasibility study has taken into account internal and external factors that influence the design. This includes current initiatives such as ICAO ANP, SESAR, DMEAN, EUROCONTROL concepts (advanced FUA, Advanced Airspace Scheme etc.) as well as the FABEC common operational concept.

Military requirements were considered throughout the design process - a process which included military representation from all partners. The study considered the unique chance to establish airspace structures that are operationally driven and independent from national borders overcoming existing interface-related problems. The airspace design work targeted improvements for the long term, but also paid particular attention to short term improvements.

5.3.1 Military involvement and input into the design process

Military representatives from all partners were actively involved in the design work. In particular airspace use requirements were thoroughly integrated into the designs although in many cases it highlighted an imbalance between the future airspace use plan (AUP) needs and the future civil traffic demand and associated airspace changes needed to process that demand.

A number of military assumptions/constraints were considered within the FABEC airspace design process:

- Combining the efforts of both the military and civilian partners was a vital and important catalyst for the airspace design work and will be crucial in a future successful implementation of the FAB concept.
- FUA Level 1 remains (and will remain) a State responsibility.
- Variable/modular training areas are acceptable if safe and operationally sound. Fixed, subdivided and prioritised areas may be safer and better for capacity in the heart of the core area. Operational needs (onboard maps, mission planning etc.) and military controlling capacity may prevent relocation of OAT missions.
- Mission effectiveness requires flexibility to enable last minute airspace changes, unhindered use of training airspace and a maximum flying distances of 60 - 100 nautical miles (varies depending on each State) between training area and the airbase concerned.

5.3.2 Redesigning FAB airspace: medium and long term

The overall benefits that could be gained from a new design for the total airspace of FAB Europe Central were considered, within the understanding that relevant changes would only be possible to implement in the medium to long term. Optimising the route network and sectorisation will have benefits in all operational performance areas: safety, capacity, flight efficiency, environmental impact and mission effectiveness.

Given the size and complexity of the airspace under consideration, as well as the uncertainties associated with predicting the traffic and flows that needs to be handled in the medium to long term future, a pragmatic approach, on a macroscopic level, was considered appropriate for the purpose of the feasibility study.

Future flow network

Although the current network is already optimised within the boundaries of each FABEC Member State the study identified room for cross-border improvements considering the overall view of the FABEC operational needs. Through additional coordination with neighbouring FABs further improvements may be derived.

The network was developed as a flow network, in next phases of FAB development the flows will need to be developed further into one or more parallel routes.

The redesigned FABEC flow network shows the potential for more direct routes, leading to improved flight efficiency, saving miles flown and fuel burn.

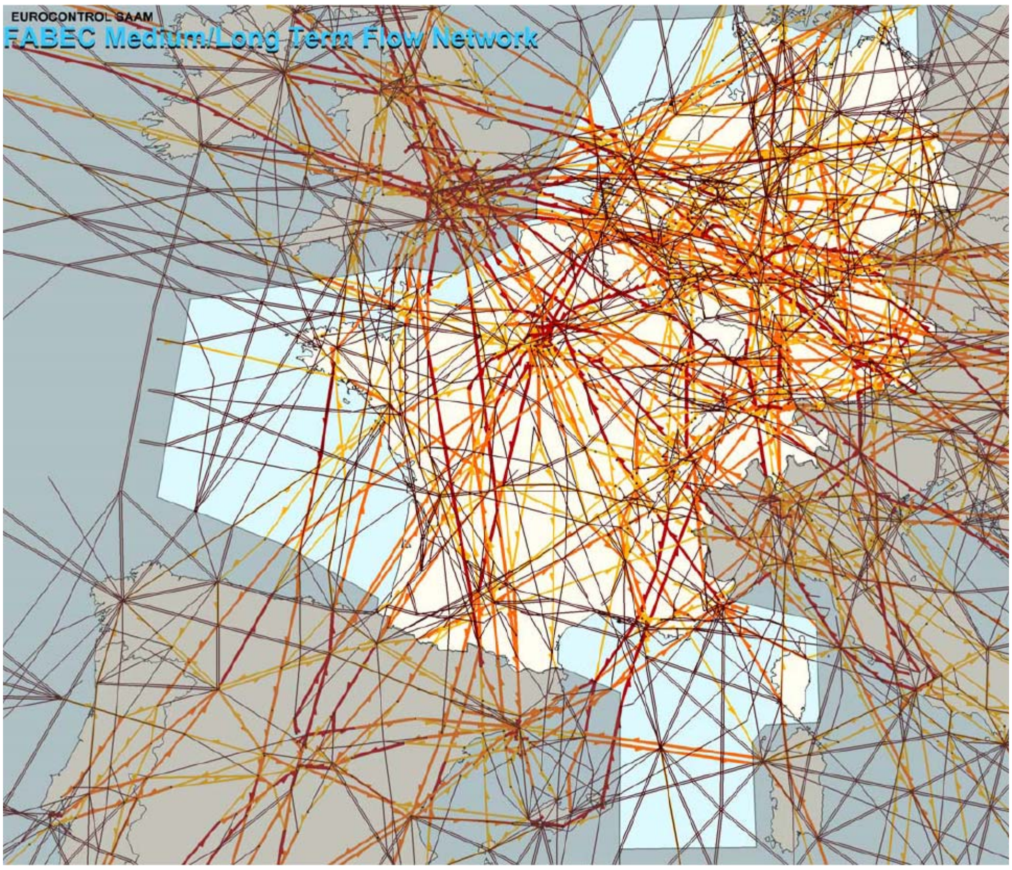

Figure 11 Medium/long term flow network

<u>Military training areas</u>

Within the FABEC core area the design of the military training areas took into account the redesign of the FABEC flow structure. Within this flow structure, areas of lower traffic density were identified, so-called ‘white spots’, and these areas were used as a basis for the design of training areas. The design focussed on cross-border options to accommodate the military requirements for enlarged training airspace in this area. The subdivision of the military training areas was optimised to make best use of the limited airspace for civil and military demand within advanced FUA applications.

The approach of using ‘white spots’ as potential locations for military training areas was analysed by military partners. Based on this analysis, the following common statement was made by these partners:

> “*The proposal to identify ‘white spots’ does not fulfil the future military requirements. But based on a list of assumptions and the possibility to create ‘grey spots’ in denser civil areas where civil traffic will be rerouted, the possibility exists to fulfil all future requirements.*”

The impact of this issue will need to be addressed further in the next stages of FAB development. A balance between civil and military requirements needs to be established.

<u>Sector family scenarios</u>

For the feasibility study, sector families have been designed rather than detailed sectors. Sector families are groups of closely interdependent sectors. Control of traffic can be optimised within such families. Within the current study, three different sector family scenarios have been developed, each using different optimisation criteria, to show the strategic direction for the long term airspace design, targeted to overcome the fragmentation of the FABEC airspace.

Resulting from today's experience, between 2000 and 3000 flights per day are considered to be a manageable traffic load for one sector family. However, this depends on the individual sector layout that needs to be designed for each family in future development steps; this degree of detail could not be provided within the time frame of this study. For the design itself, an iterative process between testing different family shapes and/or division flight levels and the constant analysis of the traffic load for each family and the interaction between the sector families was applied.

Examples of development principles that were used are a focus on traffic from major hub airports and priorities for specific traffic flows. The figures below show examples of the designed sector families in the higher levels (in two cases above FL315, in a third case above FL355) of the different scenarios. Further details are provided in Annex D.

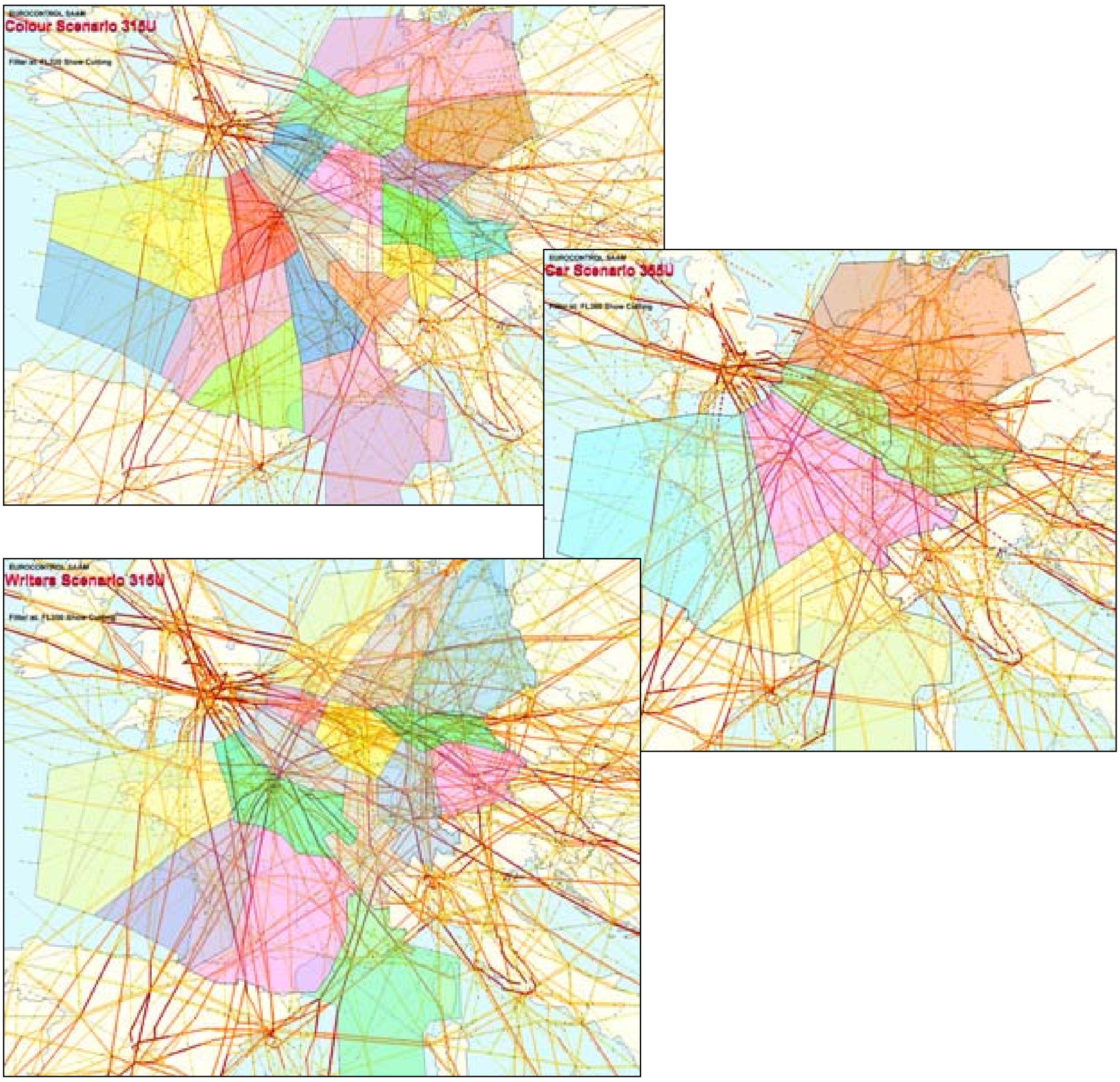

Figure 12 Examples of sector families

The development of these three scenarios provides no level of precedence. Other sector families can and should be developed by using different optimisation criteria (vertical and horizontal flight profiles) and development principles such as other division levels or prioritisation of other (e.g. north-south) traffic flows. Such models for sector families should be developed in next phases of FAB development. In these phases, a detailed study should also be performed into the impact of the different scenarios in other areas such as technical infrastructure.

Tailored routes

The concept of tailored routes was described as part of the operational concept. In tailored route airspace aircraft will be able to flight plan their own user-preferred trajectories.

The preferred trajectory may change from day-to-day because of changing airspace restrictions, the differing strategic options of the flight operator and by the vagaries of the weather and other traffic. The development of automated support systems in the air and on the ground, coupled to new procedures and working arrangements in ATM, will permit the use of tailored route operations in managed airspace (airspace of defined dimensions within which air traffic control services are provided to IFR flights and to VFR flights) and so provide significant benefits in flight economy and flexibility for users.

To accommodate the implementation of the tailored route concept, analysis focussed on these parts of the airspace where implementation would lead to a manageable number of potential interventions by controllers to avoid conflicts. It is clear that the concept can not be applied to the high density areas in FAB airspace, and therefore two aspects were considered: applying the concept above a specified flight level and at certain times of the day.

The application of the tailored route concept was considered feasible above FL385 during the whole day. Based on additional detailed studies another option could be the application of the concept above FL375. During night time between 22hrs and 4hrs UTC the application of the concept seems to be feasible above FL245.

SAAM evaluation

After macroscopic analysis of the outputs of the described steps, using the SAAM tool, the following conclusions can be made:

- A new flow network based on a natural flow demand was developed showing potential for route length reduction.
- A number of sector family scenarios depict possible future organisation arrangements that are independent from political borders, all showing relatively balanced family traffic loads and an operationally relevant number of interactions between them.
- Different tailored route concepts that can dynamically be combined were developed. The application of these concepts will provide benefits in flight efficiency and flexibility for users and expands the potential for further route length reductions.

5.3.3 Short term airspace design

Reorganising the airspace of FABEC as described in Section 5.3.2 can deliver significant benefits, but will also be very time consuming. Full implementation will only take place in 2018 and beyond. To deliver benefits to the users in the meantime and address some of the existing bottlenecks, airspace design in the shorter term has been considered, i.e. before implementation of the redesigned airspace of the full FAB area.

As fragmentation of airspace and interruption of natural flows are most prominent at the interface between adjacent States/ANSPs, the short term airspace design concentrated on three interface areas in the current airspace. These areas are referred to as ‘hotspots’ and are well known for their high workload and complexity:

- ARKON/Rekken (RKN)
- Nattenheim (NTM)/ Diekirch (DIK)
- Trasadingen (TRA)

The work on airspace design on these areas was performed completely in line with the work on long term airspace design, making the short term design a first step towards the long term design.

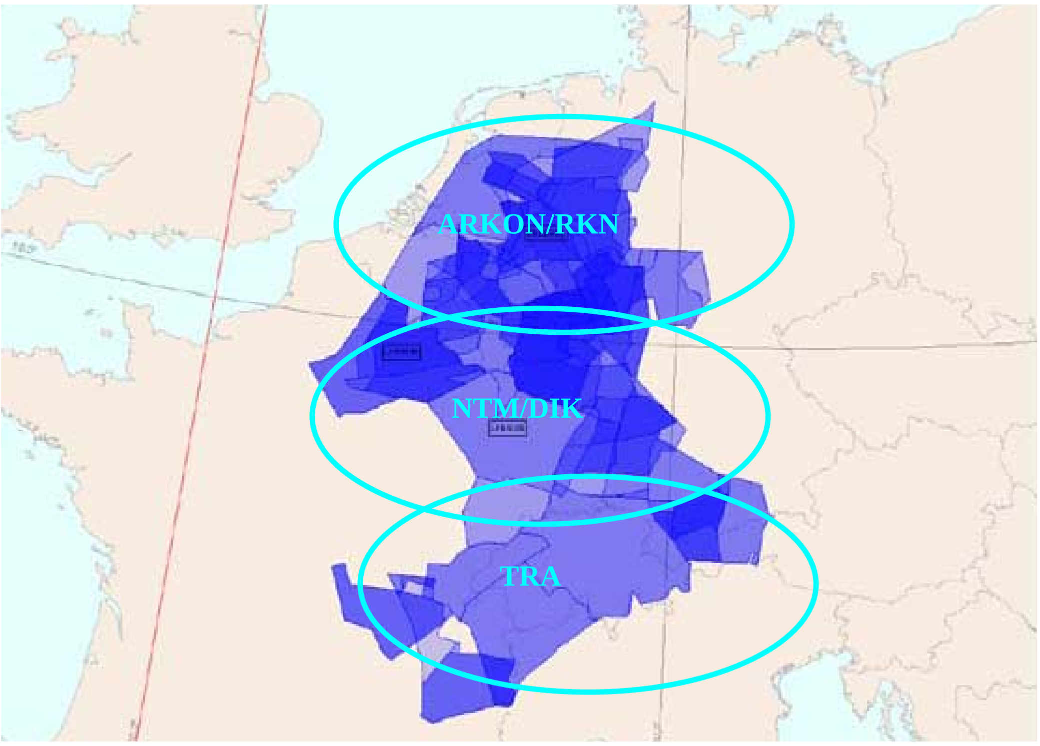

Figure 13 Hotspot areas

Three simulation scenarios, one for each hotspot, were developed and subsequently merged into one overall airspace design model ensuring a seamless transition from one hotspot design scenario to another.

This overall short term airspace design model, comprising 76 control sectors, formed the basis for the execution of a fast-time simulation using the Total Airspace and Airport Modeller (TAAM) simulation tool. Although the magnitude of the benefits achieved varies between the different hotspots, the results indicate improvements for the overall airspace concerning:

- Reduction of potential conflicts
- More balanced distribution of sector workload
- Intensive application of cross-border sector arrangements
- Reduction of airspace complexity

These improvements will consequently result in an increase of ATC capacity, whilst maintaining mission effectiveness.

The implementation of the short term airspace design requires one FAB en-route unit rate.

5.4 Common technical approach

The strategic objective for the feasibility study has been to identify the technical measures necessary to enable the timely implementation of the operational roadmap, overcome the present fragmentation of ATM systems in the core area of Europe and ensure that future developments follow a joint roadmap towards common technical [sub-]systems and common technical services which takes advantage of opportunities for performance improvement.

As a result of the study, very clear opportunities have been identified for setting up a technical cooperative framework between FABEC partners, which will offer significant leverage for the development of performance driven ATM/CNS systems and technical services. This partnership includes a cooperation between civil and military partners. This far-reaching partnership will make it possible to bundle and pool the know-how and technical expertise of participating ANSPs and to address effectively the challenge of exploiting the latest technical developments in the core area of Europe where traffic density is the highest.

The study focused on a wide range of technical systems including ATS, CNS, and ATFCM/ASM. It sought opportunities beyond classic boundaries and even considered a joint approach to control and monitoring of CNS systems and technical fallback systems. Finally, it reviewed technical systems linked to different operational units such as en-route, approach (APP) and tower (TWR) control.

In line with the ambitions of the Single European Sky legislation, it is clear that ‘Business as usual’ is no longer a sustainable option and the future technical infrastructure must actively support the performance-driven ATM/CNS framework based on well defined safety, capacity, cost effectiveness, flight efficiency, environment and mission effectiveness targets which are defined in Section 2.3. The feasibility study has developed an advanced operational concept and ambitious implementation packages (see Section 5.2) which require that the technical infrastructure provides the most advanced levels of automation and interoperability.

The technical response aims for convergence of currently diverse technical systems towards common future technical systems. In a serious bid to prevent any duplication of effort, the technical response is in line with SESAR and related deliverables were scrutinised by technical experts when determining future solutions.

The solution strives to be an early implementer of future interoperability requirements within Europe. In addition to supporting more advanced data management concepts inherent to SESAR, this approach also lays the groundwork for a more competitive common procurement approach which goes well beyond synchronizing procurements and makes possible common development, training and maintenance.

To support efficiently the concept of operations that will be in force in this particularly dense area of the European airspace, leading-edge technical sub-systems (e.g. iTEC and COFLIGHT) will be deployed. This will lead to common validation activities and the early implementation of new technology.

The migration towards common systems will take place as soon as legacy technical systems are phased out. To prevent unnecessary costs, broadly speaking, no accelerated replacements are planned and no significant additional costs without associated benefits will be imposed on the airspace users.

The increased commonality between systems will make it possible to develop cost-effective solutions for technical fallback systems, as well as the use of technical infrastructure to meet contingency requirements.

The successful implementation of the technical systems roadmap features a shift from fragmented technical development by each ANSP to common strategic planning for major investments and a common response to regulatory requirements for common technical systems.

5.4.1 Different types of cooperation

In order to study the different types of cooperation that will emerge at the technical level, the FABEC partners agreed on clear but simple definitions:

- Common specification: This refers to the specification for a technical [sub-]system, which is jointly studied, planned and validated, including functional and non-functional requirements (e.g. quality of service).
- Common technical [sub-]system: This is a technical [sub-]system, which is jointly studied and planned, specified and validated, procured and developed for more than one member of FABEC.
- Common technical service: This refers to a maintenance service for a common technical [sub-]system used by more than one member of FABEC for which ATSEPs received common training.

The increasing levels of cooperation are illustrated below.

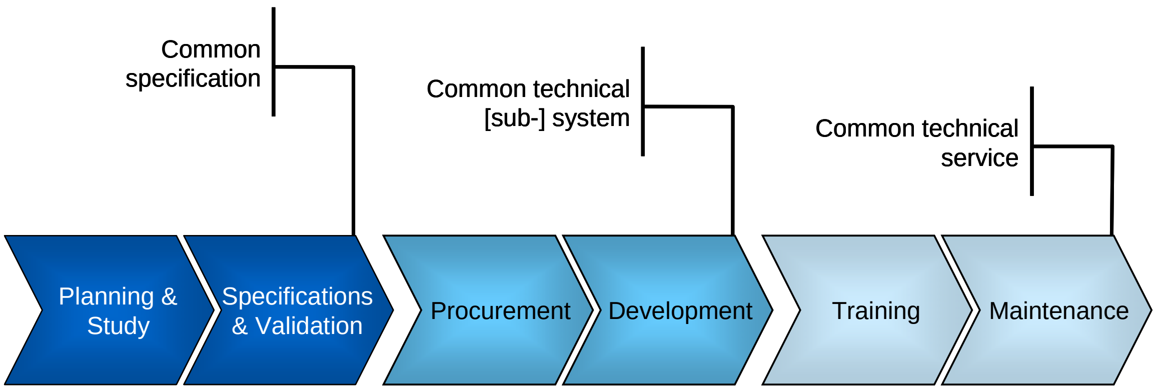

Figure 14 Illustration of the [sub-]system lifecycle

5.4.2 Technical systems roadmap

The study has produced a roadmap for technical systems, which covers the major medium- to long term technical developments. The roadmap covers progression which ranges from planning and specification, through an intermediate stage featuring greater cooperation through joint procurement activities to the possible joint maintenance of common systems. Details of the roadmap are provided in Annex E.

The technical roadmap has been integrated with the implementation plan of the common operational concept into the overall FABEC roadmap as presented in Section 7. The key technical infrastructure related themes of the FABEC roadmap are the following:

- A pace which matches the operational requirements, for example delivering major FDP upgrades from 2013 onwards in order to support the introduction of 4D trajectory management and dynamic sectorisation.
- A common approach for implementation of CNS infrastructure based on initial optimisation of the CNS networks and then further cooperation to realise more common systems, facilitating the establishment of common technical services.
- Establishment of a FABEC common technical strategy to realise a regional ATFCM/ASM function in the FABEC region. The first steps will see the widespread establishment of strategic ATFCM/ASM by 2013 and pre-tactical/tactical ATFCM/ASM following in the period 2014-2018.
- Establishment of common data services in the FABEC region.
- Establishment of ATS infrastructure in two system streams assumed to be built around the two major candidate FDP sub-systems iTEC and COFLIGHT.

These themes illustrate the gradual progression towards a common architecture for technical sub-systems.

The technical roadmap as presented in Annex E furthermore shows that for some of the roadmap themes - particularly the CNS-related ones - cooperation can lead to common systems after having agreed on common specifications. For some of these CNS systems relatively short timescale windows of opportunities might exist for common specifications.

For other more complex systems, the introduction of common systems will require a longer planning time span, with sufficient time allocated to specification and validation activities for current systems to reach the point when their replacement becomes cost-effective, commercially viable and easily acceptable by the operational end-user.

5.4.3 The way ahead for technical [sub-]systems

An assessment of the impact of the technical roadmap on operational planning has concluded that the roadmap supports the three main implementation axes foreseen in the FABEC operational concept in 2009, 2013 and 2018.

The first phase mostly covers strategic aspects whilst phases 2 and 3 relates to pre-tactical and tactical aspects. The pre-tactical and tactical phases come closer to real-time operations and hence impose higher demands on the capabilities of the technical [sub-]systems. It will be important to improve the integration of the operations related to the management of flexible transitions between flight phases. This means implementing a system which can provide coherent information management based on data exchange between different systems (e.g. ATFCM/ASM system and FDPS). Processing these data requires next-generation data processing systems.

The ATFCM/ASM Function requires a major new technical system to optimise FABEC operations and makes use of different tools (technical [sub-]systems).

As time progresses, it is noted that data evolves from purely ground based systems towards airborne systems. Data from airborne sensors will be used to improve the accuracy of trajectory based systems.

It has also been observed that there are areas - beyond main implementation packages of the common operational concept - which indirectly generate benefit for FABEC stakeholders. These often result from a closer cooperation between the ANSPs. The related areas are AIS, contingency (see Section 5.8.3), common technical [sub-]systems and common technical services.

5.5 FAB safety management

The first priority of air navigation service provision is safety. Safety is considered a prerequisite of implementing FABEC, independent of the content of the operational concept, the airspace design or any other aspects of the cooperation.

All of the civil FABEC ANSPs currently have their own safety management system (SMS) - as required by the Common Requirements of the Single European Sky regulation. A three stage process has been defined to bring together the FAB safety activities and SMS as shown in Table 6.

It should be noted that this timeline for the different stages of the process is not linked to the organisational framework for the ANSP cooperation but describes the functionalities of a common Safety Management Office in stages of maturity. As long as the institutional model of the FAB does not yet allow for integration of functions, all ANSPs have their own safety certificate and associated responsibilities which cannot be shared. This means that every ANSP by law will require their own safety management system with accountability to the highest level in that ANSP. A common safety management system is not possible (although they may look very similar). Once the FABEC institutional model develops into a state which does allow for integration of functions, a common safety management system for FABEC can be developed that subsequently would have to be certified by appropriate authorities (probably a group of NSAs).

Notwithstanding the above, it is proposed that the preparations for the development of a common safety management system should begin at the earliest possible opportunity. This development is divided, for ease of reference, into three development stages, each one more advanced than the previous one and representing more cooperation and commonality between the ANSPs.

At each stage a number of activities will take place to integrate and improve the FABEC SMS and supporting processes such as shown in Table 6.

Stage 1	Stage 2	Stage 3
Establish Safety Management Office Define stakeholder safety cooperation framework Define and implement framework and methodology for safety regulation and oversight Establish quantified safety levels Define safety risk assessment and mitigation methodology and processes Develop and deliver safety assurance for FABEC changes Integrate FABEC Safety Assessment Methodology with ANSPs' risk assessment and mitigation methodologies Integrate approaches for safety assurance of changes between FABEC and individual service providers	Establish safety policy & safety KPIs Establish quantitative and qualitative safety targets Start integration of safety management training Define harmonised safety performance monitoring processes Establish harmonised auditing processes Establish harmonised safety promotion processes Commence integration of ANSP risk assessment processes Develop detailed requirements for a harmonised SMS	Finalise the FABEC safety organisation Establish management system for controller competence, certification/licensing and ongoing assessment Establish management system for engineer competence, certification and ongoing assessment Establish a safety research & development function Establish an integrated SMS manual and processes

Table 6 Stages of development towards a common SMS

At an early stage it is envisaged that a FABEC Safety Management Office will be established. This may be either a physical office with seconded staff or a 'virtual' office supported by web tools. An example of the required functions for the FAB Safety Management Office is shown below. It is possible to start with a 'skeleton' office and add functions incrementally, in line with increasing FABEC cooperation.

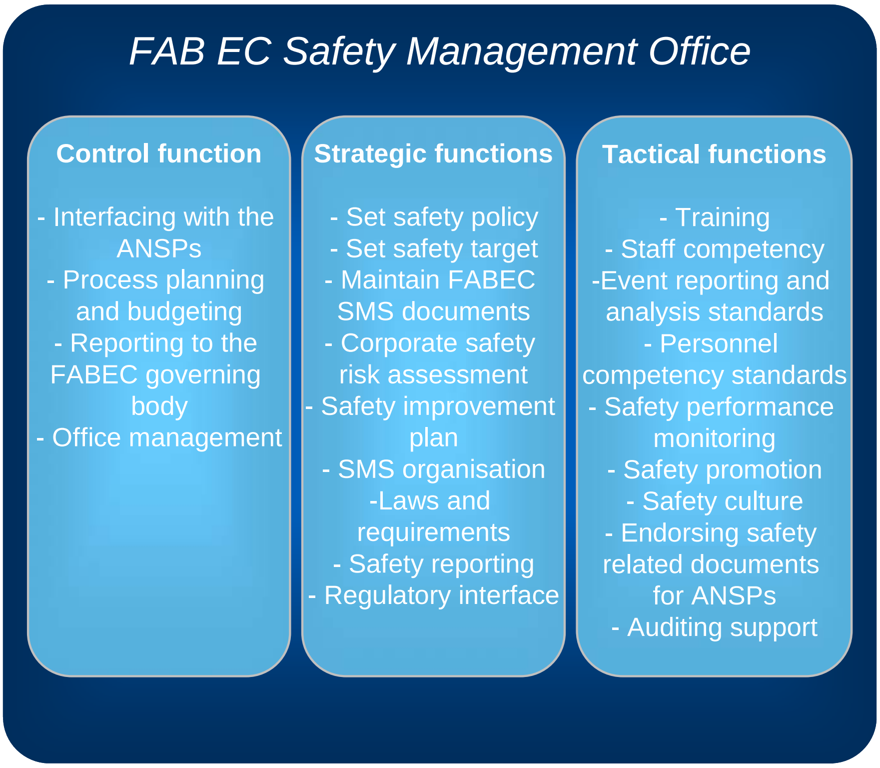

Figure 15 FAB Safety Management Office functions

As the FABEC level of cooperation becomes more intense, noting that the cooperation may be faster in some areas than others, the need for performance improvements in the safety area will become paramount. Steady and incremental enhancement of the safety processes across the FABEC ANSPs will be facilitated by the Safety Management Office. The primary aim is to improve the effectiveness of the SMS by adopting the best practice of each ANSP across the FAB. A secondary aim will be to realise efficiency benefits as the enhancements progress. For safety, it is envisaged that a single safety management system will be developed, and a single distributed safety management organisation will be implemented.

5.6 Common charging

The study has reviewed the options for charging in the FAB and recommends that the whole of the airspace in the FAB should constitute a single charging zone, with a single unit rate. This recommendation is made because:

- It has the virtue of simplicity
- It would be welcomed by most users (for example, it is supported by IATA)
- It will bring benefits in itself, since inefficient routing designed to minimise user charges will not longer be encouraged
- The cost base pooling inherent in a single charging zone is a vital prerequisite for obtaining cooperation among ANSPs in implementing FAB initiatives.

The cost bases of the six Member States would be pooled to establish a single cost base for the charging zone. The unit rate for the charging zone would then be the rate obtained by dividing the total cost base by the total service units calculated for the charging zone.

The revenue collected for the charging zone would be divided among the participating civil ANSPs in the ratio of their individual cost bases.

This cost base pooling is considered a vital feature of the charging regime for the FAB. Pooling the cost bases in this way makes the revenue earned by each ANSP independent of the traffic that it attracts to its airspace. It is regarded as vital in that there is no 'competition for traffic' between ANSPs, and that traffic should be encouraged to route itself in ways that minimise total costs to FAB stakeholders.

5.6.1 Practical issues with the single charging zone

A number of practical issues were noted with the single charging zone:

- The change in the number of service units
- The impact on individual users of the single unit rate
- The way that disparities in taxation and exemptions were determined on a national basis

The change in the number of service units

It was noted that the service units calculated for the aggregate charging zone would not be equal to the sum of the service units for the individual prior national charging zones. This is because the services units are calculated based on the great circle distance between the entry and exit points of the charging zone. With a larger, aggregated charging zone, this quantity will be lower than for a collection of smaller, disaggregated zones. Using CRCO data, the study estimated that the service units with the single FAB charging zone would be around 1.5% lower than the sum of those for the national charging zones. To ensure collection of the same revenue, this would mean that the unit rate for the aggregate charging zone would need to be around 1.5% higher than the arithmetical average of the individual national unit rates, although the net position for all users would remain the same.

The impact of the change on individual users

It was noted that if a group of five national charging zones with disparate unit rates are merged into a single charging zone with a single unit rate, some users will benefit through lower charges and some will lose out through higher charges.

Current unit rates are around €70 for Switzerland and for Belgium and Luxembourg; around €65 for Germany; around €60 for France and the Netherlands (see Figure 5 on page 37).

If these rates were replaced by a single unit rate, airlines that fly mainly through Switzerland, Belgium/Luxembourg and Germany's airspace will see an overall reduction in en-route charges; those that fly mainly through French and Dutch airspace will see an overall increase in en-route charges. Some convergence in unit rates is, however, expected over coming years. According to current projections, the rate for Germany is expected to fall to a value close to of the current value for France and the Netherlands, and that for France to rise slightly (although the rates for Switzerland and for Belgium and Luxembourg are expected to remain at their present, relatively high, levels)

This redistribution of charges will be unacceptable to some users, and because of this will be an obstacle to implementation. If national unit rates converged, however, it would reduce this differential impact and strengthen the acceptability of the FAB across all users. Two options for a metric of such convergence are proposed, so that states can assess the appropriate point to make the switch to a single unit rate. One is based on arithmetic differences between the unit rates themselves, and another on the overall impact on users.

The first convergence metric simply takes the differences between the national unit rates and the FABEC average, and calculates from them an average deviation by the national share of the FABEC cost base.

The second makes specific allowance for the fact that any given airline will have both net gains from the single unit rate (where it flies in a relatively expensive national zone) and net losses (where it flies in a relatively cheap national charging zone). Most airlines will do both, and therefore any given airline's net gains or losses will be lower than the first metric implies. The second metric takes account of this, measuring the proportion of total user charges transferred from winners to losers.

Disparities in national taxation and exemption rules

At an early stage, it had been suggested that disparities in national taxation and exemption rules could give rise to problems. However, if States take the decisions that are needed to support the implementation of the FAB, it appears that solutions can be found.

The problems arise as follows:

Different national tax regimes apply value added tax (VAT) using different rules. While most flights are zero-rated for VAT purposes in most jurisdictions, there are certain exceptions. For example, non-commercial flights by German operators are liable to VAT on their en-route charges for the portion of their flight that is subject to German VAT regulations. The same is true for Switzerland.

The CRCO advised that they could provide information on the proportion of service units, and hence of charges, in the aggregate FAB charging zone, that arose from flight through a particular country's airspace. Furthermore, they would be happy to collect VAT as necessary, for any separate 'billing zones' for which a separate VAT rate was chargeable. It was recognised that any convergence on VAT policy was very unlikely to be influenced by considerations arising from the ANS industry.

A similar issue arose with exemptions. Exemptions from en-route charging are, according to the Common Charging Regulation (and current practice) in some cases mandatory, and in some cases at the discretion of individual States. In all cases, States are required to fund exemptions. The CRCO again expressed their willingness to take into account particular national exemptions within an aggregate charging zone. A flight, for example, that was exempt in one jurisdiction but not in another could be appropriately billed.

In practice, differences in the discretionary exemptions between FABEC states are very minor.

5.6.2 Implementation of the common charging zone and the single unit rate

To implement these proposals, it will be necessary for the Member States in the FAB to agree to:

- Establish the charging zone
- Produce, annually, common submissions on the costs and unit rates for the charging zone for the European Commission and EUROCONTROL
- Produce similar submissions for the en-route billing organisation (currently the CRCO)

The common submissions would need to include a statement of the cost base for the FAB ANSPs. It will also need to include statements of the cost base for organisations other than the national ANSPs, who are expected to receive revenues from route charges.

The billing organisation should be instructed to distribute receipts among the ANSPs in proportion to their respective cost base. This could either be directly (like the current practice in some FABEC States) or via the State's government (like the practice in others). While a single system could have the virtue of simplicity, it is not critical to the success of the FAB. Continuing diversity of methods of reimbursement could be allowed to persist, if the States wished. Agreements would be required among the ANSPs, the States, and the billing organisation to implement this.

The timing of the introduction of the single charging zone and the single unit rate should be before the introduction of the operational improvements in the congested 'hotspots', which involve cross-border sectorisation. Failure to implement a single charging zone before this becomes operational would necessitate complex revenue-sharing arrangements to ensure that ANSPs had no incentive to compete for traffic in these areas. It would also reduce the benefits, since users might be tempted to choose routes that optimise route charges rather than system costs.

It was regarded as an essential part of the financial cooperation mechanism that there should be mutual oversight of costs, leading to joint management.

5.7 Cooperation in training and qualification

Implementation of a common operational concept in combination with convergence towards common technical systems and services will enable the opportunity for strong cooperation in the area of training. Such cooperation will improve the cost effectiveness of the provision of training, and may also improve the effectiveness of the FAB-wide application of the operational concept.

Moreover, harmonisation in training will bring benefits such as increased job attractiveness and opportunities for mobility.

The FAB feasibility study has already shown that a strong consensus on the training philosophy exists. By joining forces it will become easier for training centres to acquire the tools (equipments, methodologies, etc) needed to achieve their goals and the FAB objectives. They will have a stronger position in the regulatory process.

Cooperation in training will be an evolutionary process, following the developments in other areas. However, cooperation in training would offer benefits regardless of cooperation in other areas.

5.7.1 ATCO training

In the long term vision on ATCO training, when sufficient harmonisation has been achieved, in particular in the operational and technical areas, a single training organisation will be possible. Given the dependency on commonality in other areas, such an organisation is only relevant in 2020 and beyond.

The continuum of training from recruitment and selection, initial and unit training through to recurrent, conversion and development training is of paramount importance and this should continue to be the case in the FAB situation. The single training organisation should be part of the FAB to preserve the continuum of training, involve available ATCO expertise, allow better and quicker coordination with operational units than both current situation or an outsourced training organisation and provide a continuum of management philosophies between the academies and the operational units.

Developments in other areas will enable cooperation in training: for example, with a common system in the FAB, one type of simulator can be used throughout all the phases of training. If a common supervisory authority is implemented, this body can govern a harmonised training and licensing system in the FAB. Such a common supervisory authority, or at least a common regulatory framework, would be needed to achieve full benefits that can be expected from FAB training.

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. By moving elements from OJT to pre-OJT or even initial training, it would be possible to overcome the OJT bottleneck.

As indicated, 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 areas and partly because by nature making revolutionary changes to training is not possible. These two reasons together do however form a strong basis for a step-by-step approach in harmonisation and cooperation in training.

The existing recruitment, selection and training systems in the FABEC 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 and clear opportunities to cooperate to maximise the success rates of selection and training and to improve cost effectiveness. The evolutionary process will lead from sharing of information and materials in the short term, through common development and some common courses in the medium term, to the single training organisation with generalised common courses in the long term. The application of this process may differ between the phases of training, as for example the content and format of unit training largely depends on (local) operational needs, making harmonisation more difficult than in the initial training phase.

The single training organisation can be situated at a reduced number of locations for initial training if this improves cost effectiveness, although reduction to a *single* location is not considered advisable. The most important reasons are to avoid the link to local operational units being reduced or lost and to ease the availability of instructors. It could also ensure redundancy of technical systems used for training.

5.7.2 Civil/military cooperation in training

A common vision on training cooperation between civil and military ANSPs in a FAB future will have to be defined, knowing that the current situation in civil/military cooperation differs between countries from full integration to no cooperation. Furthermore, it should be considered that, with respect to national safety/air defence and specific military aspects, additional training and perhaps even separate training facilities on a national level may continue to be needed in the short to medium term. A number of points should be taken into consideration when looking further into cooperation between civil and military.

A common licensing scheme could be developed that is applicable for civilian and military personnel. Also a common selection battery and Common Core Content (CCC - similar standards) for training, similar for civil and military, should be possible, in combination with specific military add-ons, in a FAB-future. However, it depends on the model of cooperation to what extent military and civil personnel will be integrated. By 2015, it could be feasible to develop a common basic course (in initial training) and CCC (in unit training) to manage both civil and military traffic. Harmonised procedures developed in the long term, would have no restrictions on handling GAT/OAT.

5.7.3 ATSEP training

Both developments within this feasibility study (in particular in relation to the operational concept and technical infrastructure as described earlier in this section) and external developments (such as the SESAR concept of operations and associated follow-up documents) clearly indicate that a rising level of automation and integration of technical systems is envisaged. This fact implies that availability and integrity of technical systems in FABEC will become more and more important, and that the complexity level of each individual system and the overall ones is rising as well.

The more complex the systems are, the more there is a need for qualification to maintain current operations on a very high level of availability. At the same time however, harmonisation of the technical systems across the FAB area is foreseen.

ATSEP competencies are regulated by ESARR5. An ATSEP minimum training standard (Common Core Content) will become effective in FABEC by about 2010.

In general, the evolutionary process in cooperation on ATSEP training is similar to that for ATCO training: from sharing of information in the short term, through common development of materials and courses in the medium term, to the single training organisation with common courses in the long term.

In the long term, training will be more modular than today, so that there are specific course for communications, navigation, surveillance and data processing. The option of a limited number of training locations also exists (for basic and qualification training), if this improves cost effectiveness, but one *single* training location is not considered to be advisable in order to cater for sufficient contingency, flexible capacity and concentration of competences. Each location could (but will not necessarily have to) deliver both ATCO and ATSEP training. In order to avoid duplication of technical infrastructure, each training location can be specialised in particular parts of communications, navigation, surveillance or data processing equipment training. A proper balance will have to be found between this specialisation and the benefits of having several locations for a given initial training.

5.8 Other opportunities

Several other opportunities for cooperation were discussed within the detailed feasibility study. Concepts were developed and the potential cost and benefits analysed, but it is recognised that further study (e.g. regarding technical feasibility) and decisions are required (in particular in relation to institutional arrangements) before these opportunities are developed in more detail and implemented at FAB level.

5.8.1 Aeronautical information services

Air Traffic Management relies extensively on the provision of timely, relevant, accurate, and quality-assured aeronautical information that enables stakeholders to make informed decisions. The current product-centric provision of AIS will evolve to become a more data-centric solution, in which aeronautical information will be more dynamic and will be made available for use for applications such as flight planning, flight management, navigation assurance, separation assurance, collaborative decision making (CDM) or other tactical ATM activities.

FABEC implementation will facilitate a common AIS concept of operation in order to support the safe and orderly provision of aeronautical information, services and products in accordance with relevant ICAO standards and recommended practices, covering all phases of flight. A concept has been designed to meet the requirements of the stakeholder community and to support agreed EUROCONTROL and SES initiatives.

For the development of the concept, different approaches to AIS provision were considered.

- Option 1 - the centralised approach: one central AIS, from data collection to data publication, with a single point of contact as customer interface.

- Option 2 - the networked approach: national AIS centres remain but activities are coordinated through an AIS network. The customer interface is a virtual single point of contact.
- Option 3 - the combined (networked/centralised) approach: regional AIS centres for data collection. Harmonisation, production and publication by central AIS centre, with a single point of contact as customer interface.

The three main criteria against which the approaches were assessed were safety, capacity and cost effectiveness. Additional criteria included political acceptance, institutional barriers, SES compliance, social aspects and compatibility with ongoing activities. The combined networked and centralised approach emerged as the preferred scenario, with it being the only solution to have a positive impact on all of the main criteria, and to have no perceived negative impacts on the additional criteria.

An overview of the concept, and of the development towards the concept, is provided in the figure below.

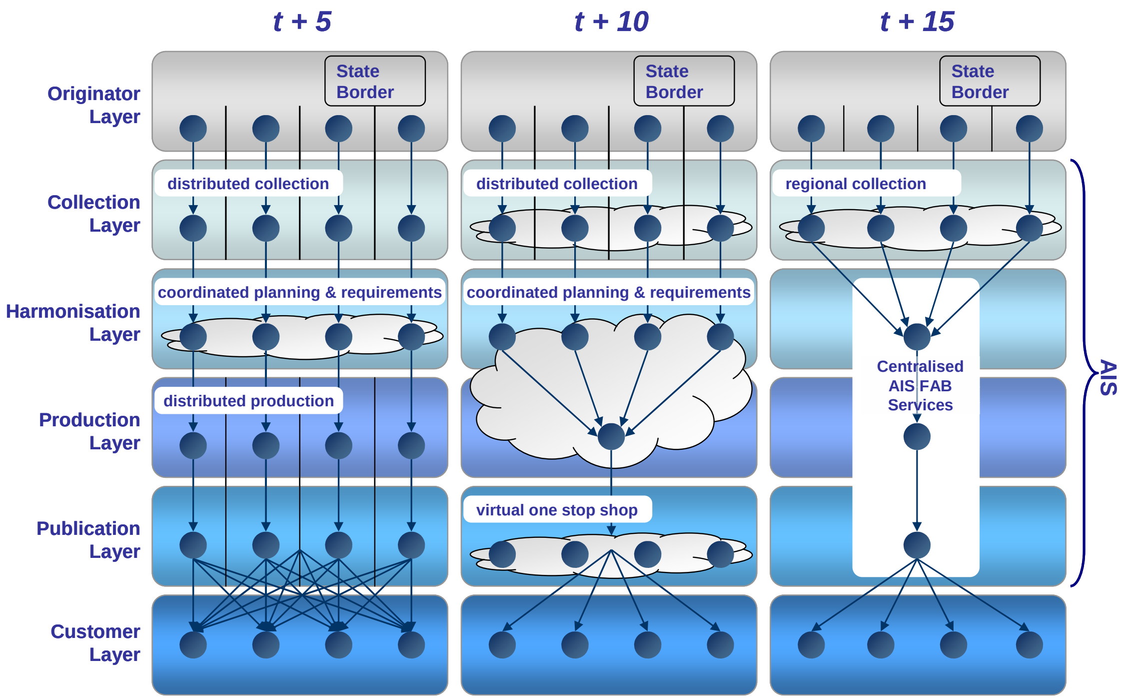

Figure 16 Combined centralised/networked AIS concept

5.8.2 Meteorological services

Accurate and timely delivery of MET information is vital to ensure safe and expeditious operations, and to ensure that capacity is fully utilised. Future operations will be more reliant on regularly updated and accurate MET information: extreme weather conditions, such as fog, strong winds and thunderstorms can have a severe impact on operations. Whilst the impact of such weather conditions cannot be mitigated completely, improved MET information can help to reduce the impact of weather-related ATFM regulations on air traffic.

A FABEC concept for the harmonisation of the MET information collection, distribution and integration procedures as well as the ATS requirements for MET information has been developed. Similar to the AIS concept, a centralised approach, a networked approach and a combination were considered.

From an operational point of view, the preferred solution is an interoperable MET information management concept that will integrate MET information in the ATS systems. It is a combined networked and centralised concept that initially focuses on coordinated data collection, with the harmonisation distribution and integration of MET information being centralised.

The concept was assessed to have a positive impact on both capacity and cost effectiveness without having a negative impact on safety. MET information contingency plan requirements were also considered to be well addressed.

An overview of the concept and the intermediate steps is again provided below.

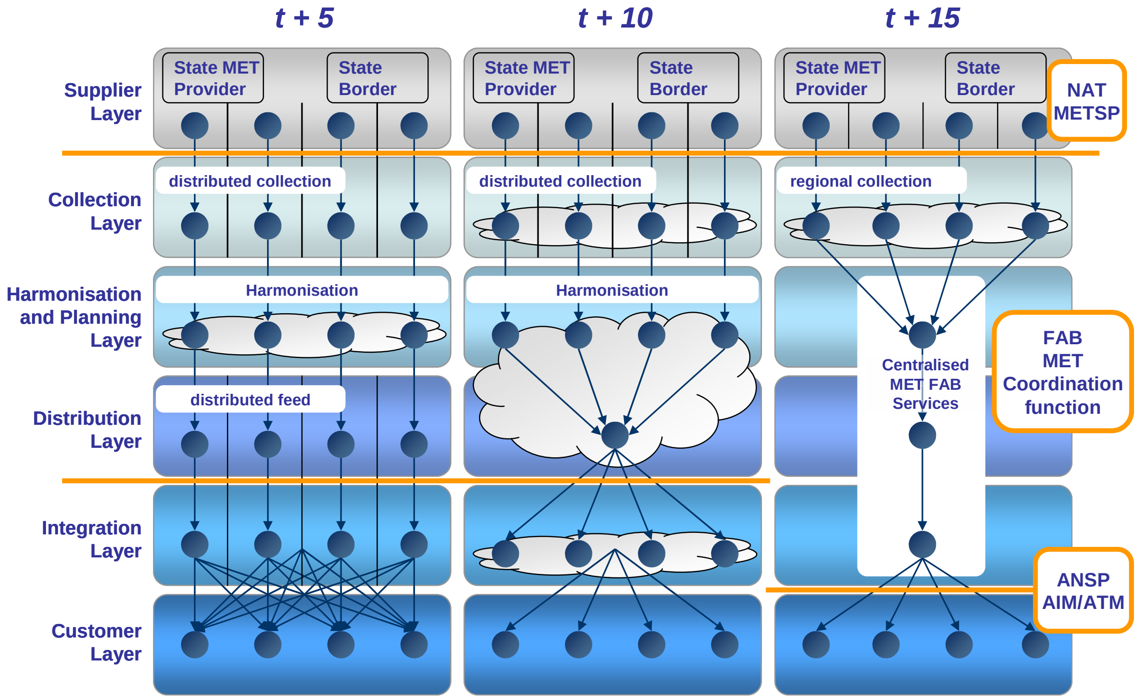

Figure 17 Combined centralised/networked MET concept

5.8.3 Contingency

A contingency concept was considered at FAB level. The target of the concept is to provide common contingency for the main traffic flows in FABEC. The concept applies to all UACs, ACCs and the main APP units.

The FABEC contingency concept consists of two phases: 'immediate actions' and 'service continuity'. The immediate actions concern the first 30 minutes after a contingency event and all FABEC ANSPs already have developed and implemented a number of procedures for this phase. These procedures could be harmonised between FABEC partners thereby increasing safety and efficiency.

Major benefits are estimated to come from the FABEC contingency concept in the service continuity phase. In the concept a catastrophic outage of one of the 20 FABEC control centres (UAC/ACC/APP) supporting the main FABEC traffic flow is considered. The outage of any of these centres would cause major disruptions in the core airspace of Europe. The

FABEC contingency concept aims to mitigate the negative impact of the outage by a quick recovery to service provision levels of at least 70-80% of day to day capacity after a set time frame. Hereby, the concept aims for the optimum balance between required costs (financial, social) on one side versus safe/robust/sufficient service levels on the other side.

The situation per ATC control centre regarding inter alia types of traffic, equipment and airspace structure differs widely. The contingency concept foresees for every participating unit a tailor made plan with an optimum mix of the available contingency measures, whereby the relocation measure will be the most prominent. The study showed that from an operational point of view, the relocation measure has the most potential to provide sufficient and sustainable capacity levels for longer periods.

Several options were considered for implementation of the relocation measure. The preferred option is a regional solution with contingency facilities attached to a limited number of existing centres. This option contains the following advantages:

- Easier to realise than some other options as regional solutions may be extensions of existing centres
- Results in a dispersed contingency availability throughout the FABEC area, closer to hand and at shorter distances from the normal location of operation
- Results in more diversity of contingency facility systems (i.e. HMI, ATC system processing and capability etc) which are more aligned to the existing local systems; this will simplify the cost of contingency training of ATC staff
- Proximity of contingency facilities will reduce the costs for relocating personnel for training as well as during real contingency operations

Implementation of the contingency concept across FABEC will require major changes to the technical infrastructure and it will be necessary to determine optimum operational and technical solutions.

Military participation in the FABEC contingency concept and the contingency requirements will be determined on a case by case basis by the responsible military authority based on specific military needs and interests.

6 Options for the FAB institutional model

Three models for cooperation have been considered in the feasibility study: 'contractual cooperation', 'alliance' and 'single ANSP'. Given the areas of cooperation and the achievements that could be made in the early years of FABEC, the study has concluded that the implementation of FAB improvements may be best suited to a progressively growing level of cooperation, but this does not rule out a final step to a single ANSP. An initial study of the suitable legal forms for the different models has been made but requires further study. There remain some outstanding questions on the position of military ANSPs in the cooperation.

This section considers the cooperation requirements to enable the implementation of the improvement areas foreseen from the study and describes different 'models' of cooperation. The section describes the preferred legal forms for these models, which were deduced by considering the range of possible forms available in public and private law. The section presents an illustrative roadmap for the evolution of these cooperation models, considering incremental steps towards the ambitions for the FAB. Finally, the section discusses the governance structures for the early stages of the FAB, including coordination with States and military ANSPs.

At each stage in the following discussion there are options for FABEC. These options require policy decisions and more in-depth investigation to ultimately decide the preferred institutional structure for FABEC. It should also be noted that the feasibility study has not assessed the impact of the models of cooperation on the current governance structures of the ANSPs, as this will largely depend on policy decisions to be taken after the study.

6.1 Models of cooperation

6.1.1 Levels of cooperation

The FABEC project has defined five levels of possible cooperation between ANSPs:

1. Exchange of information: ANSPs maintain their financial and legal independence. Fully autonomous decision making, but with mutual information exchange.
2. Coordination: ANSPs maintain their financial and legal independence. Fully autonomous decision making, but with joint coordination of plans.
3. Contractual cooperation: ANSPs maintain their financial and legal independence, but establish joint decision making processes in agreed upon specific areas with sharing of costs and benefits possible.
4. Integration: ANSPs partially give up financial and legal independence to create joint organisation(s) in specific areas with other ANSPs (from functional cooperation to establishment of joint venture companies).

5. Consolidation: ANSPs lose their financial and legal independence and are merged into one ANSP or will be jointly owned by a single supra-national ANSP organisation.

At cooperation levels 1 and 2 the ANSPs retain their full financial and legal autonomy. At the third cooperation level ANSPs also remain fully autonomous, but have contractually agreed to run their business within a framework of certain joint decisions. At the fourth cooperation level the autonomy of the ANSPs will be reduced and at the fifth level it will disappear.

6.1.2 Models of cooperation

Only for levels 3 to 5 are formalised and eventually institutionalised cooperation structures necessary. Hence only these three levels of cooperation have been analysed and are defined as the models of ‘contractual cooperation’, ‘alliance’ and ‘single ANSP’.

The principal distinction between the contractual cooperation and the two other models is that in the contractual model no integration of functions will take place. The ANSPs stay fully autonomous in the provision of all services, but cooperate to improve the overall FAB performance by a joint harmonisation and standardisation programme. No joint legal entity will be established to provide managerial and administrative support to the programme.

In the alliance and single ANSP models integration of functions can take place. The principal difference between the alliance model and the single ANSP model is that in the alliance model the ANSPs remain the designated ATS providers. Under the alliance model an evolutionary increase of cooperation will be possible, including integration in some areas. This integration is primarily focussed on support and ancillary services (CNS, AIS and training), but it may also be possible to establish joint ATS units.

The single ANSP model includes a full integration, into one single provider (or one single provider organisation owning the ANSPs), of all ATS provision in the FAB. In this model the current ANSPs would only retain those ATS provision functions that may stay outside the FAB cooperation, such as Tower services.

6.2 Progressively growing areas of cooperation

6.2.1 Influence of areas of cooperation on models

The study has assessed the main areas where cooperation at contractual or higher level will be required to support the FAB improvements. In deciding whether higher levels of cooperation were essential or desirable, the study considered the following points: the need for structured managerial and financial support of joint developments; decision making; and the need for a legal entity to establish centralised units.

The areas of FAB cooperation could be classified in respect of the means by which improvements may be achieved:

- Improvements which will be implemented inside ANSPs
- Improvements which will be implemented through centralised units

These two means of implementing improvements each require a fundamentally distinct governance model, which will be essential for the choice of the preferred legal form.

Improvements which will be implemented inside ANSPs

This is the case in the majority of the cooperation areas: airspace design, technical infrastructure planning, charging, business planning, performance management, manpower planning and safety management. In these areas decisions to implement improvements are taken jointly, but each ANSP will autonomously be responsible for the implementation of the improvement within its own organisation.

Performance of the FAB will be the main driver for improvement and joint performance management will be the core of the cooperation. A joint performance management team will monitor performance and will analyse improvement potential. Joint development teams (or project teams) will be established to prepare improvements. These teams will have no executive powers: the implementation decisions will be made by the steering body.

Each ANSP will need to agree to the proposed policy decisions and, in agreeing, accepts responsibility for implementation in its own organisation. This implies that policy decisions in general will have to be taken by consensus. However, decisions will need to be binding, especially in areas with financial consequences for all parties involved. The issue of sanctions for breach of the obligations contained in the agreements must be further investigated. Implementation coordination teams may be installed to assure a FAB-wide consistent implementation. In the first years of the cooperation the development teams will be joint teams staffed with experts of the respective ANSPs. However, for an effective process it is advisable to appoint permanent staff for the management of the teams. This would require cooperation at alliance level.

Improvements which will be implemented through centralised units

The cooperation areas in which the implementation of improvements will take place through the establishment of central units require a governance structure enabling the transfer of executive powers to the units for day to day management. This is the case for the ATFCM/ASM function and for ancillary services.

The possibility for ANSPs to participate in such centralisation depends strongly on the legal form of the cooperation. For military ANSPs it may not be feasible to transfer executive powers to a legal entity established for FAB cooperation under private law. Also for some civil ANSPs, this may be questionable, dependent on national policy regarding the positioning of public services.

6.2.2 A progressively growing level of cooperation

Whilst contractual cooperation may be sufficient to support improvements implemented inside ANSPs, it is expected to play a limited role in establishing centralised units. Contractual cooperation is, however, likely to be a convenient vehicle to quickly begin FAB cooperation. The alliance model is attractive in that it could be used to support improvements inside ANSPs and establish centralised units. By default, the single ANSP model encompasses both means of implementing improvements.

Given the areas of cooperation and the achievements that could be made in the earlier years of a FAB, the study has concluded that the implementation of FAB improvements may be best suited to a progressively growing level of cooperation. The study has assessed approximate timescales, which indicated that contractual cooperation can serve as the appropriate model for a quick start up of the FAB in 2008. However, to better manage joint development work and decision making, a stronger cooperation may be required by 2010. A legal form enabling the establishment of centralised units would be required by 2013. These points are returned to in section 6.4.

Whilst all of the areas of improvement were found to be supported by the alliance model, the single ANSP model may nevertheless be chosen for other reasons, such as its additional performance potential, or on the basis of institutional considerations. The single ANSP model may also be a longer term option if the designed improvements were not in future found to be sufficient in meeting the performance targets.

6.3 Investigation of legal forms

A first investigation of a wide range of options for the legal form of the three cooperation models was performed. The final selection of the preferred legal option for the different phases of progressing cooperation will require an in-depth further study in the definition and implementation phase of the FABEC project.

Some legal forms were found to be less suitable for ANSPs cooperation, such as where they are incompatible for membership by skyguide or EUROCONTROL, others had conflicting objectives with those of the FAB cooperation, or others were less suitable given an unlimited liability of the members or shareholders or an insufficient role for the founders of the organisation. The summary assessment identified the following promising legal forms for the FAB:

- Association of ANSPs, with legal personality. An association can be established in each of the six States. Each national law provides for a form of not-for-profit association. In some States the association's purpose must be linked to non-profit or charitable activities, while in other States, such as Belgium, France and the Netherlands, the association can pursue economic activities. In all cases, the association cannot distribute profits to its members.

- Company under private law (i.e. non-treaty/public international law). A private law company generally has a profit seeking purpose which, dependent on the tasks of the company, may cause some strain with the strict cost recovery nature of air navigation services. This has to be properly addressed in the articles of incorporation.

- International public law organisation: International Organisation (IO) or International Public Corporation (IPC). An International Organisation (IO) and an International Public Corporation (IPC) both have to be established by international State agreement (Treaty). Both options offer considerable freedom with regard to the governance structure. An IPC is in fact a variant of an IO. It is a special purpose organisation entrusted with autonomous powers, that provides services to private persons or that governs the use by these persons of the intrastate or interstate public domain (in this case the airspace). IPCs usually focus on providing services to private individuals (in this case airlines), while IOs are usually formed for the benefit of member States. The IPC also offers the possibility for ANSPs to become shareholders, an important condition to assure their close involvement in the evolutionary growing cooperation. In summary, the IPC should be seen as the preferred option over an IO.

The IO and IPC are primarily options for the single ANSP model. However, the IPC option can also be used for the alliance model.

The association and the private law company (owned by ANSPs and/or States) will be primarily options for a private law cooperation between ANSPs. The private law company form could also be an option for the single ANSP model. States could set up a private law company pursuant to a corporate merger process. But in all cases, even if the merged ANSPs take the form of a private-law entity, a FAB Treaty will still be necessary to determine how the participating States will continue to control and to impose public policy objectives on this entity.

6.4 Possible roadmap for ANSPs' cooperation

As noted earlier, implementation of FAB improvements may be best served by a progressively growing level of cooperation. To establish a firm roadmap, however, has not been possible during the feasibility study as this is subject to State level policy decisions and further analysis. Nevertheless, it was felt worthwhile to propose a possible but pragmatic cooperation roadmap for debate and adaptation in future work.

Given the study's view that the implementation of FAB improvements will require a progressively growing level of cooperation, an illustrative roadmap has been created, as follows:

- 2008: contractual cooperation to start the ANSPs' cooperation
- 2010: alliance model, 1st phase, for better structured managerial and financial support
- 2013: alliance model, 2nd phase, to enable the establishment of centralised units
- Optional final step: single ANSP

It should be noted that during the first years of cooperation, institutional solutions will have to be compatible with current status of ANSPs and their staff.

6.4.1 Start up of the FAB – contractual cooperation

Contractual cooperation is the best suitable model for a quick start up of the FAB (in 2008). The ANSPs will conclude a contract (or contracts) to start cooperation in a selected number of improvement areas, with the focus on those areas where they jointly can realise short term priorities and first benefits within the limits of the existing legal and institutional frameworks.

Cooperation agreement

The contract should describe amongst others:

- The purpose and objectives of the cooperation
- The areas of cooperation
- Working structures - for example, steering body (CEOs Board), performance management team, development and implementation teams
- Governance and reporting structures
- Resources and budget (including financial arrangements)

6.4.2 First phase of the alliance (2010 – 2013)

As concluded previously, a transfer to a stronger cooperation framework under the alliance model may become necessary by 2010, to better support the joint realisation of improvements. The scope of cooperation in this phase will be joint development of improvements followed by joint implementation decisions. Implementation takes place inside the individual ANSPs. Establishment of centralised units (ATFCM/ASM, technical services, training, AIS) is not yet foreseen in this phase.

The advantage of a cooperation structure with legal personality will be the limited liability of the members and the possibility to conclude contracts with third parties, which is a necessary condition if the association would need staff, external assistance or office facilities.

In this first phase, only private law (i.e. non-treaty) based solutions are feasible. Promising candidate legal forms may be an Association with legal personality or a private law company (owned by ANSPs an/or States). However, the final choice will require further study of legal models and a closer investigation of possible requirements for States involvement in the ANSPs' cooperation framework.

An Association is a relatively light structure that can be set up in due time to enable a short term start of the FAB. It offers sufficient flexibility to facilitate the learning process in this phase of the FAB and to prepare for a stronger vehicle in a later phase when cooperation intensity increases. Given the limited scope of the cooperation in this phase a private law company may be an option for some of the identified areas of improvement.

It is to be expected that all seven civil ANSPs can join an Association. However, proper mandates will be required under their current governance structures to provide for an effective policy decision making process in the alliance. In the governance structure of all ANSPs specific approval procedures exist (at State or supervisory level) for certain policy, budgetary and/or investment decisions.

Cooperation agreement

The articles of association establishing the alliance will depend on the legal form and the national law of the State of establishment. In addition internal rules may be needed for specific aspects of the cooperation, such as joint social dialogue and user consultation.

6.4.3 Second phase of the alliance (2013 and beyond)

By 2013 a cooperation framework enabling the establishment of centralised units may be required. The choice of the preferred legal form for this phase will depend on policy choices:

- Whether integration of ancillary services will be part of the FAB cooperation or will be left to initiatives outside the cooperation. Integration outside the FAB cooperation can take place through joint initiatives of some ANSPs, which may be FAB or non-FAB partners, or through outsourcing of services. The choice may be dependent upon States' policies regarding unbundling of services.
- Whether ANSPs will develop joint ATS units.

Dependent upon these choices different preferred legal forms are apparent for the FAB cooperation:

1. If air traffic services are not to be integrated (alliance model), and integration of ancillary services is to be left outside the FAB cooperation, the cooperation model can stay at the level of the initial phase: the cooperation will continue to be focussed on evolutionary increased harmonisation and standardisation.
2. If air traffic services are not to be integrated (alliance model) but integration of ancillary services is to take place within the FAB a legal entity has to be established that is suitable to provide ancillary services and can apply for the certification of such services. Promising legal models could be a private law company or an International Public Corporation managed by ANSPs.
3. If establishment of joint ATS units should be possible within the alliance, but integration of ancillary services is left outside the FAB cooperation, a legal entity is necessary that is suitable to provide ATS and can be certified for such services.
4. If establishment of ATS units should be possible, and integration of ancillary services is included the FAB cooperation, a legal entity is necessary that is suitable for the provision of both ATS and ancillary services.

An overview of these options is shown in the following figure.

	Ancillary services	
Joint ATS units?	Integration outside the FAB cooperation?	Integrated inside the FAB cooperation?
No	*Alliance for managerial and administrative support only*	*Alliance enabling centralisation of Ancillary services*
Yes	*Alliance enabling establishment of joint ATS units*	*Alliance enabling establishment of joint ATS units and centralisation of ancillary services*

Figure 18 Centralisation requirements dependent on policy choices

6.4.4 Optional final step: single ANSP model

The establishment of a single ANSP may be a possible final step in a progressive integration process, rather than an immediately available option, given the lengthy institutional process required. An agreement has to be reached on the legal form for the single ANSP, a detailed treaty has to be negotiated, and the disappearance of the national ATS providers will require fundamental legislative (or perhaps even constitutional) changes in the States.

But even after this lengthy institutional process a 'big bang' scenario to integrate the ANSPs into a single ATS provider is unrealistic given the large differences between the ANSPs. A considerable level of harmonisation and standardisation in systems and concepts will have to be realised before integration of ATS provision into a single provider can take place.

On the basis of the above two arguments the most realistic scenario is to consider the single ANSP model as an optional final step to be decided after an evolutionary development under the alliance model.

Alternative roadmap: early choice for the single ANSP model

As an alternative roadmap an early choice for the single ANSP model is possible. During the years of institutional preparations as described above, the ANSPs would cooperate under an alliance model. Once the institutional process has been completed, the ownership of the seven ANSPs could be transferred to the new organisation. Under this common owner the ANSPs would continue the growing cooperation until full integration.

6.5 Evolution of governance arrangements

The feasibility study has limited its exploration of governance arrangements to the early stages of the FAB, in anticipation of further work in this area following certain policy decisions. This section therefore discusses the governance structure for contractual cooperation, the Association (initial phase of an alliance), and coordination with States and military ANSPs.

A particular requirement of the governance structure is to include performance management. The performance of the European ATM network will become a core element in the SES II package recently announced by the European Commission. Therefore a performance driven management of the FAB will have to be a core element in the governance structure of each FAB model.

6.5.1 Governance structure for contractual cooperation

The governance structure for contractual cooperation can be kept relatively simple as the contracting parties will not establish a joint legal entity. A possible structure is shown in Figure 19. The development task forces could be under a dedicated project structure developing deliverables to be implemented in the ANSPs. The position of military ANSPs in the cooperation is left open because of the uncertainties around the feasibility of their direct participation in the contract. An alternative could be the establishment of civil/military coordination at policy level and a liaison structure at expert level in areas requiring military involvement.

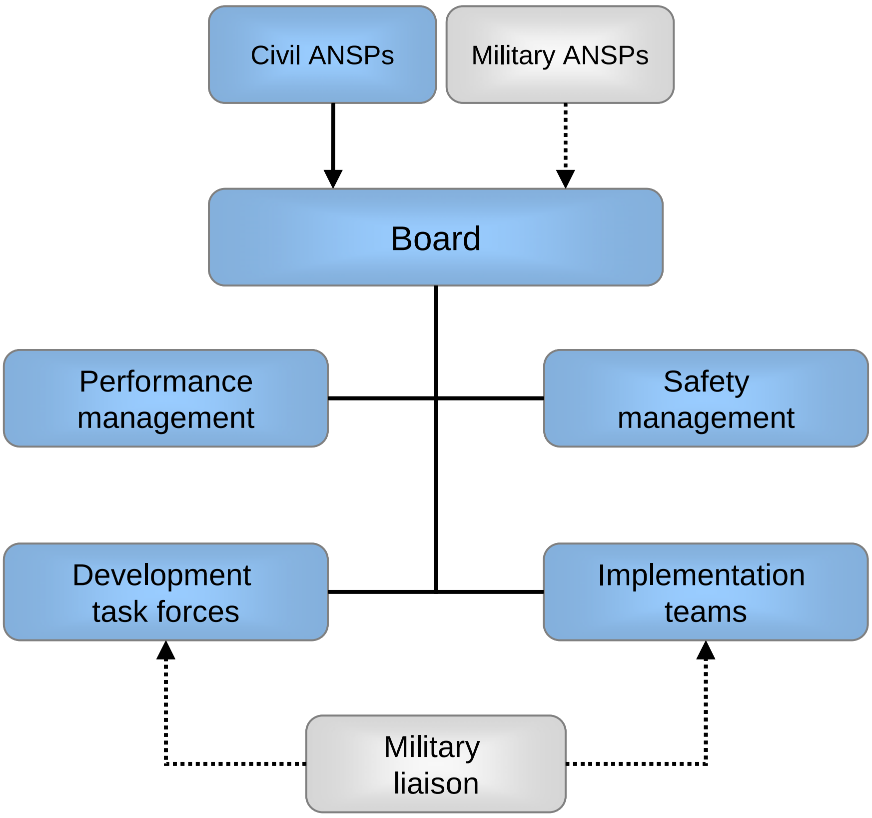

Figure 19 Governance structure for contractual cooperation

(Note: Development task forces may be under a dedicated project structure instead of under the ANSP cooperation governance structure.)

6.5.2 Governance structure for an Association

The Governance structure for an Association under the alliance model will be more complicated than in the contractual cooperation model. There will be a need for a joint policy on decision making, and a stronger performance management function. The development teams and the performance management team will need day to day management, office facilities and administrative support will be required.

The main characteristics of a possible governance structure for an Association are given in Figure 20.

The joint teams and the ATFCM/ASM function will be manned by ANSPs' staff. Day to day management could be delegated to executive management staffed by the Association.

Feasibility of full participation of military partners is not clear yet and requires further study. Membership of military ANSPs is given, where full civil/military integration is achieved on national level, otherwise it is kept optional. In most cooperation areas a failing military participation in development and implementation of improvements will impact the cost effectiveness of the FAB. However, in two areas full military participation is essential for the overall performance of the FAB: airspace design and ATFCM/ASM. In the case military ANSPs cannot participate directly in the Association the involvement of military ANSPs in these two areas has to be assured through a civil/military coordination structure at policy level and participation via liaison officers at expert level.

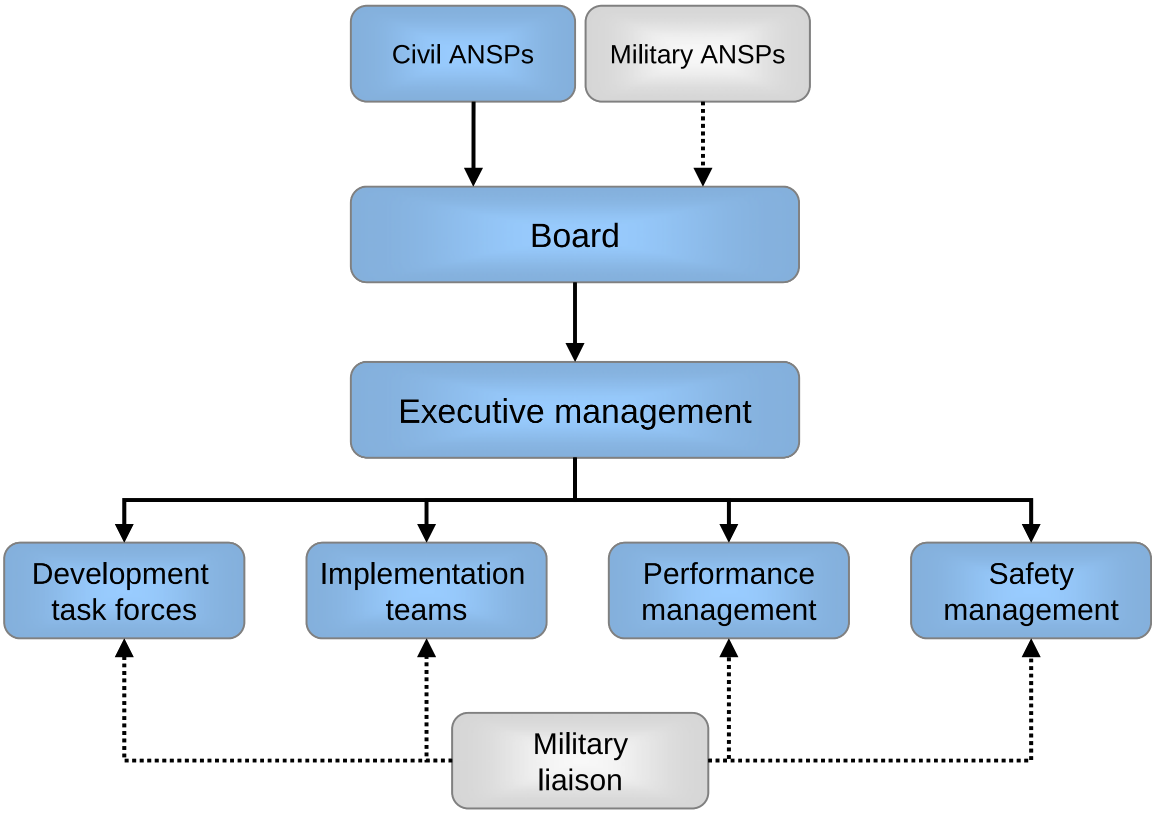

Figure 20 Governance structure of an association in the initial phase (alliance model)

(Note: Development task forces may be under a dedicated project structure instead of under the ANSP cooperation governance structure.)

6.6 Coordination with States and participation of military ANSPs in the cooperation

ANSPs Cooperation will need a close coordination with the States' high level policy body, specifically in the areas of airspace design, airspace management, charging and supervision.

Whilst military ANSP participation in the FAB is essential for its overall performance, there remain uncertainties in the military perspective, i.e. the feasibility study has not received full input from military ANSPs on all issues.

The feasibility for military ANSPs to participate in a cooperation structure may depend on the legal form of the cooperation. In particular, the transfer of executive powers to legal entities established under private law may be difficult or even impossible for military ANSPs. However, the start up phase of the FAB will necessarily have to be based on a private law cooperation between ANSPs, because of the long lead time of an international cooperation based on a State agreement. Also in the follow up phase, cooperation forms based on private law could be preferred, depending on the scope of the cooperation.

6.6.1 Civil/military cooperation models

In the feasibility study, three models were identified through which civil/military cooperation at FAB level could be realised to such an extent that ATM in a FAB would benefit to the desired degree, without impairing the efficiency of either partner. The preferred model for civil/military cooperation is an issue that, at least initially, needs to be addressed at national level by the involved States. As a result, the models are references only and should not be considered as part of the proposed FAB development at this stage. These models were identified as: a minimum model, a pragmatic model and an optimum model:

- The ‘minimum’ model builds on the present situation and endeavours to harmonise and align rules, and regulations, organisational assets, procedures and resources. It does not change the present set-up of ATM in their areas of responsibilities, but tries to minimise differences of operation. It will, however, introduce a higher management structure to harmonise planning activities throughout the FABEC.

- The ‘pragmatic’ model, foresees a closer partnership between civil and military organisational units but still retaining the independence of the present ANSPs and their hierarchy. Civil and military ANSPs would still exist but in a much closer partnership based on equal recognition. The underlying theme, however, is the achievement of greater co-operation at all levels serving both organisations’ interests but also ensuring improved efficiency in airspace management and traffic flows. Building on the experiences gained through the minimum model, the cooperation within the higher level management structure will start standardising planning, training, purchasing activities.

- The third model based on a visionary concept, called the optimum model, envisages a new organisation based upon a single ANSP with responsibility for the provision of services to a common FABEC standard for both civil and military air traffic; this would include the capability to handle the requirements of military approach control procedures. This FABEC ANSP would support operations on the core principle of ‘one ATCO for one airspace’, i.e. irrespective of whether they were recruited via the civil or military system, ATCOs would be allocated to a particular area of airspace with responsibility for all civil and military traffic operating therein.

The military ANSPs recognise that win-win situations are more realistic in stronger co-operation models. An example of this is the ATFCM/ASM domain, where it is clear that most benefits to mission effectiveness, flight efficiency and capacity will come from and integrated structure including the military ANSPs. Therefore any cooperation scenario as discussed in this section, including full integration where a single provider delivers service to both OAT and GAT, is considered possible as long as clear Service Level Agreements are created allowing the military partners to fulfil the State requirements and at the same time also allowing the civil partners to achieve the performance targets that have been set.

6.6.2 Overall coordination structure

The three models described have not been further developed into the ANSP cooperation models as the models assume that ANSP-cooperation will be Treaty based, i.e. they did not address cooperation in the form of legal entities under private law. Given the need for further military inputs and clarification, the study assumed that full military participation in a private law cooperation may not be feasible. If not feasible the involvement of military ANSPs could be assured through the establishment of a civil/military coordination body at policy level and a military liaison structure at working level.

An overall coordination structure for the start up phase of the FAB, under the alliance model, is shown in the following figure. This supports cooperation between the ANSPs' cooperation entity, military ANSPs and States.

Under a single ANSP model, the governance structure would be assumed to be, by nature, a fully civil and military integrated provider.

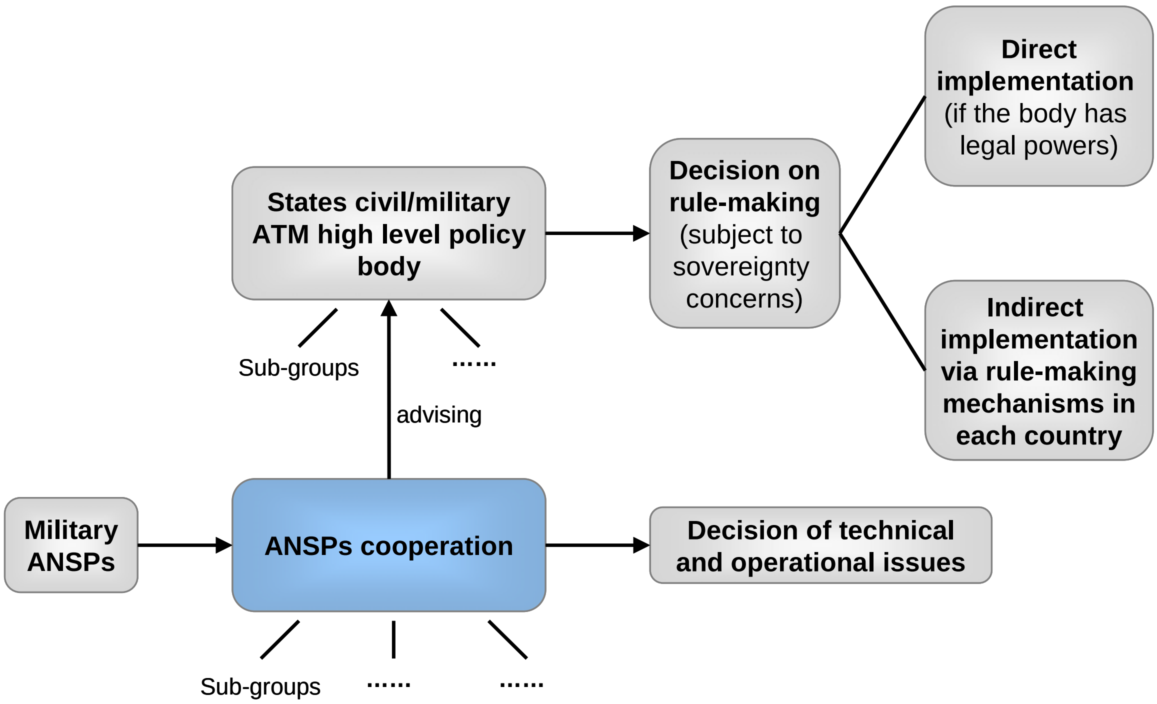

Figure 21 Coordination of the alliance with military ANSPs and regulators

7 Roadmap for FABEC

A consolidated roadmap for FABEC has been developed. This roadmap is based on the key initiatives 'operational concept' and 'airspace design', but reflect in addition other areas for cooperation. Enablers in other areas such as human resources, safety and institutional and regulatory arrangements were combined with the operational and technical initiatives, because they are mostly prerequisites for a successful implementation and the delivery of benefits. The roadmap is divided into three main phases, in line with the operational implementation plan: 2008-2013, 2014-2018, and beyond 2018.

The different areas of cooperation that have been identified as part of the FABEC feasibility study have been combined into a consolidated roadmap for cooperation. This section presents the roadmap and summarises the elements contained in it.

7.1 Content of the roadmap

The implementation plan of the operational concept has been taken as the leading element in the development of the consolidated roadmap. The three main phases that have been identified in this implementation plan can therefore also be recognised in the consolidated roadmap:

- Phase 1: 2008 - 2013
- Phase 2: 2014 - 2018
- Phase 3: beyond 2018

The roadmap is presented in Figure 22. Four distinct categories of elements can be recognised in the roadmap: operational/technical elements, further cooperation elements, ANSPs enablers and States enablers.

A separate element of the roadmap, indicated on the boundary between ANSP and States enablers, is communication on FAB-related issues. Communications of such issues are part of a continuous process and should always be performed in coordination between ANSPs and States.

In the next sub-sections, further detail is provided on the different categories of the roadmap.

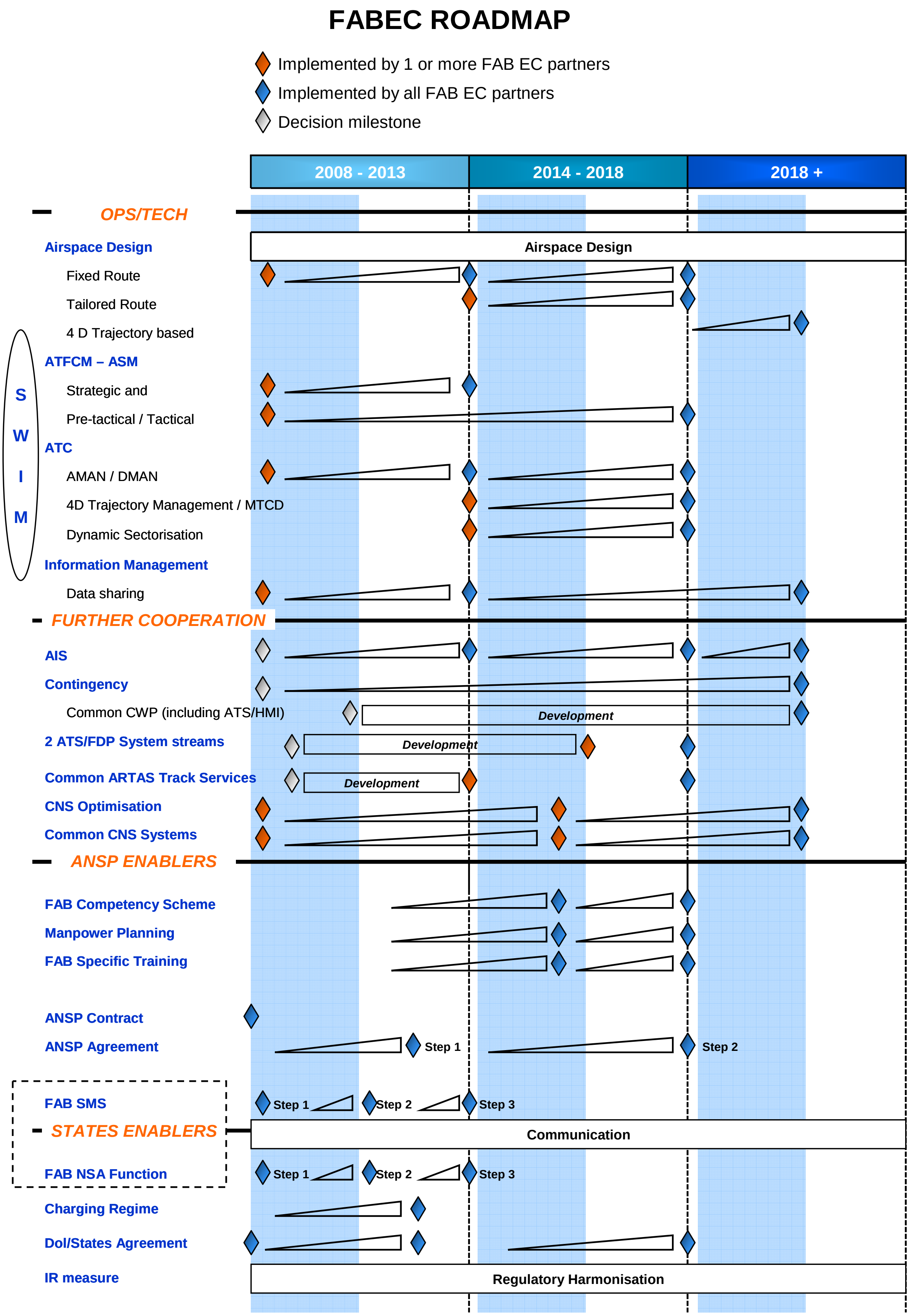

Figure 22 Proposed roadmap for cooperation

7.2 Operational/technical roadmap elements

FABEC leads to direct benefits which are mainly created by the FABEC operational concept and the related modifications in airspace design.

The modification of the airspace design is a major contributor to the FABEC performance framework. This optimisation will be a continuous task to be executed for the FAB. Airspace design optimisation can however be categorised in 2 major phases with an overall timeframe:

1. Short term: optimisation of the airspace design especially in 3 so-called hotspot areas (ARKON/RKN, NTM/DIK, and TRA). This will lead to changes in the fixed routes. The implementation is planned by 2013.

2. Medium term: an overall optimisation of the airspace design including modifications to the fixed routes, extensive use of cross-border areas and the introduction of tailored route system. The implementation is planned 2018.

Airspace design optimisation is based on fast-time simulations and real-time simulations which precede the implementation date.

The following main functions are required to support the optimisation: Fixed route system, Tailored route system and 4-D trajectory based operation.

The FAB operational concept is supported by 4 building blocks, as described in Section 5.2. Addressing airspace organisation and management through airspace design, and focussing on the ATFCM/ASM function as part of demand and capacity balancing, the following domains of improvement are considered:

1. Airspace design,

2. ATFCM/ASM

3. Air Traffic Control

4. Information Management

The 4 domains go hand in hand with technical [sub-]systems developments which have to be synchronised with the targeted implementation date of implementation packages resulting from the FABEC operational concept.

The roadmap is described at the level of these domains and is linked to functions which are in general supported by the defined technical [sub-]systems:

	Improvement domain	Function	Time frame	Technical [sub-]system
1	Airspace design	Route system Step 1 - Fixed route system Step 2 - Tailored route system Step 3 - 4D trajectory based (autonomous operations)	 2009-2013 2013-2018 2018+	Airspace design and simulation tools (fast-time and real-time)
2	ATFCM/ASM	CDM	2009-2013	ATFCM/ASM
		FAB operations plan Step 1 - Basic version (static data) Step 2 - Advanced version (dynamic data)	 2009-2013 2013-2018	ATFCM/ASM
		Sector design and management Step 1 - Dynamic sectorisation, incl. sector configuration optimiser	 2013-2018	ATFCM/ASM
		FAB scenarios Step 1 - Predetermined scenarios (static) Step 2 - Dynamic scenarios	 2009-2013 2013-2018	ATFCM/ASM
		FUA level 1, 2 and 3 Step 1 - FUA level 1 (modular areas), 2 and 3 Step 2 - FUA level 1 (dynamic areas), 2 and 3	 2009-2013 2013-2018	ATFCM/ASM
		ATFCM-related what-if probing	2011-2018	ATFCM/ASM
		Workload monitor	2011-2018	ATFCM/ASM
3	ATC	4D trajectory management Step 1 - Exchange of intentions Step 2 - Airborne data and FPL contract	2013-2018	ATS/FDP
		Sector design and management Step 1 - Generic sectorisation and exchange of sectors	 2018	ATS/FDP and CNS/VCS
		Conflict management	2013-2018	ATS/FDP and controller tools
		AMAN/DMAN	2009-2013 2013-2018	ATS/FDP and AMAN/DMAN
		Interoperability (IOP, OLDI) Step 1 - Enhanced use of OLDI Step 2 - Next generation IOP	 2009-2013 2013-2018	ATS/FDP
4	Information management	Data sharing Step 1 - Ground units Step 2 - Airborne data	 2009-2013 2013-2018+	Could be embedded in several [sub-] or a separate [sub-]system depending on the information domain (e.g. ATFCM/ASM system, FDPS, data server, etc.)
		Weather forecasting Step 1 - Data exchange Step 2 - Improve 4D trajectory management by use of airborne data	 2009-2013 2013-2018+	Data server

Table 7 Improvement domain and links to functions and systems

The above list is indicative and surely not exhaustive for all possible improvements of FABEC through cooperation. The classification in 4 domains was used to build the roadmap.

Some FABEC partners might allocate some functions to different technical [sub-]systems. This does not jeopardise the overall argument for a common roadmap which is elaborated in this paper. It can also be noted that not all partners will implement the function at the same time but that sometimes there may be early implementers in FABEC (red diamonds) and full implementation at a later date (blue diamonds). This shift in timing is caused by the technical [sub-]system capability of the systems of different partners.

By reviewing the planned developments and the associated timeline, it can be concluded that there are 3 major phases when implementing FABEC:

- Phase 1: 2008 – 2013
- Phase 2: 2014 – 2018
- Phase 3: 2018+

These phases cover strategic, pre-tactical and tactical aspects. The pre-tactical and tactical phases come closer to real-time operations and impose higher demands on the speed of the processes and the capabilities of technical [sub-]systems. Data transfer between different systems (e.g. ATFCM/ASM System and FDPS) is required. Processing these data requires an advanced data processing system.

The ATFCM/ASM System is a major new technical [sub-]system to optimise FABEC operations and makes use of different tools. An initial strategic capability will start as of 2009 and will be further developed and deployed by 2013. The tactical and pre-tactical capability will initially be created in 2009 and further be developed till 2018.

As time progresses, it is noted that data evolves from purely ground based systems towards airborne systems. Data from airborne sensors can improve the accuracy of trajectory based systems. Another trend noted was often an evolution from static data towards more dynamic data.

If technical [sub-]systems do not currently exist, then the preferred approach is to go for common developments. The benefit of the improvement will then become available for all partners at the same time. If systems are existing, then a gradual improvement will take place as existing systems are replaced or upgraded. It can be assumed that the benefit grows linearly over time as the transition from an early implementer towards a full implementation by all partners takes place.

7.3 Roadmap elements of further cooperation

It can be observed that there are other areas - beyond main implementation packages stemming from the FABEC operational concept - which indirectly generate benefit for FABEC stakeholders. These often result from a closer cooperation between the ANSPs. These areas are AIS, contingency, common technical [sub-]systems (such as CNS systems, ATS/FDP systems) and common technical services.

The CNS systems optimisation and the establishment of common CNS systems will normally be synchronised with one another.

This list is not exhaustive either, but gives the major areas of improvement through cooperation.

The implementation of the contingency concept would require major changes to the technical infrastructure and it is necessary to determine optimum operational and technical solutions (e.g. the required HMI and an adequate voice communication). Contingency needs further study work in the next phase of the project.

The MET area was considered outside the scope of the study report. The processing of raw weather data was not considered from a technical perspective. Standards and formats for the exchange of data need to be developed and agreed. The unrestricted sharing of processed weather data from a third party provider across FABEC might require further institutional action.

7.4 ANSPs and States enablers

Some of the above benefits will not materialise if a number of enablers are not in place.

For these enablers a stepped approach is often foreseen aligned with the operational/technical elements and cooperation issues described in the previous subsections. Different steps indicate that the development can be done stepwise and that all improvements do not need to be supported from the start.

HR enablers are linked to competency schemes, training, and manpower planning. It is assumed that some kind of harmonisation will be reached across FABEC. Manpower planning is a shared responsibility between the HR department and other departments.

Relevant FABEC training should be available to allow the deployment of common technical [sub-]systems across the FABEC area (as of 2013) and the implementation of dynamic sectorisation (planned initially in 2018). The planning dates to accomplish training are considered as rather ambitious. Coordination between operational, technical and training experts within the FABEC should exist as early as possible to define and implement specific training where needed.

Regarding manpower planning, it is necessary that a common method is agreed to assess the amount of operational staff needed in different FABEC centres. The definition of such a method is an operational issue. HR issues would then have to be addressed to gain full benefits of common manpower planning: harmonised initial training, mobility, etc. Progress on the HR related topics can only be achieved if similar progress is made for social dialogue.

ANSP cooperation will start with a contract in 2008. As follow-up the ANSP Agreement will also evolve over time as cooperation becomes more intense. The ANSP Agreement Step 1 will probably need an update in 2018 when more advanced functions become available.

The FAB safety management system is also expected to evolve in steps. Ideally a fully functional SMS (as of 2013) can be used to manage from a safety perspective the full lifecycle of common technical [sub-]systems.

It is assumed that the FAB NSA function matures at a pace synchronised with the development of a FAB SMS.

The charging regime and the single unit rate are expected to be established in 2011 before the time that the airspace design optimisations stemming from the hotspot areas are implemented.

As from the start of the implementation phase, decision will be needed on strategic issues (e.g. decisions on changes due to airspace design) at State and ANSP level.

The States Agreement which will be elaborated after the signature of the Declaration of Intent will probably also evolve over time to respond to enhanced functions being deployed within FABEC.

Regulatory harmonisation is a continuous process which is expected to start as of the beginning of the FABEC establishment.

Communication is a single function which is assumed to be executed at the same time for States and ANSPs.

7.4.1 Requirements on States

The consolidated roadmap specifically identifies the need for regulation to enable data sharing and dynamic sectorisation. However, the States will need to address a wider range of measures that are not all indicated individually in the roadmap. The following is a summary of the measures that were identified in the feasibility study:

- The establishment of a permanent FAB High Level Policy Body, joint civil and military, which will be responsible for:
  - Coordinated approval of airspace design changes
  - Common policy for airspace management
  - Common priority rules for ATFCM
  - Common policy on ATS airspace classifications
  - Coordinated publication of airspace structures and ATS routes
  - Harmonisation of existing rules and procedures
- Joint designation of ANSPs:
  - A balance has to be found between the interest of a seamless FAB operation, regardless of national boundaries, and respecting national sovereignty interests. The study presents 5 options. The most promising option is where each State designates the 'own' provider and the providers enter into delegation agreements for cross-border ATS.
  - Attention should be given to the certification of military ANSPs: only ANSPs certificated against the SES common requirements can be designated.
- ATS delegation:
  - In connection with the joint designation States should on beforehand approve the freedom of the designated providers to mutually enter into cross-border ATS delegation agreements.
  - The States should make it possible for military ANSPs to enter into such agreements.
  - Delegation arrangements will need sufficient flexibility in time and space to enable a dynamic and modular sector management in function of traffic flows and workload.
- Liability:
  - There is a need for a joint FAB liability regime.
- Licensing:
  - ATCO licence: There is a need for a more generic license to enable dynamic and cross-border sectorisation. Current national language abilities requirements need review.

- o ATSEP licence: National qualification rules above minimum EC requirements need harmonisation.

- Oversight:
  - o A FAB-wide harmonised supervisory regime needs to be established, covering all relevant domains: safety, systems interoperability, personnel, airspace, economic, accident/incident investigation.
  - o A growing NSAs cooperation is required, synchronised with growing ANSPs cooperation.
- Safety
  - o A common 'just culture' should be pursued in the FAB, i.e.:
    - No punishment for actions of operators commensurate with their experience and training.
    - "*No toleration of gross negligence, wilful violations and destructive acts"* [5]
  - o The differences in the national implementation of Directive 2003/42/EC (protection of safety related information) should be harmonised as far as reasonably achievable.
- Harmonisation of rules and procedures
  - o In the operational, technical, financial, safety and HR fields the study identified a large number of differences in national rules and procedures that will hinder an effective implementation of the planned improvements. States should start an ongoing program for harmonisation of these rules and procedures.

7.5 Early steps

The roadmap presented in this section covers the period until 2018 and beyond. As part of the definition of the FAB initiatives and roadmap for this period, the feasibility study has also considered the first steps in the development of the FAB. These steps include 'short term priorities and first benefits' - measures which are implemented until 2013 by 2 or more FABEC partners and which contribute directly to the performance framework of FABEC service provision - and 'support activities' - measures to define, plan and organise the implementation of FABEC or activities which are important to be carried out until the start of the implementation project.

The clearest example of a 'short term priority' aimed at delivering early benefits is the short term airspace design. By addressing some of the more critical areas of the current airspace through FAB level cooperation, initial improvements are already possible in the next 5 years.

A number of elements of the operational concept - and related technical [sub-]systems - can also deliver benefits in the period up to 2013, either through full implementation or through implementation of initial functionality (with further, more advanced functionality developed in the period beyond 2013). Examples are the ATFCM/ASM function and the AMAN/DMAN function. The same rationale applies for other cooperation areas: they can deliver benefits in the short term through full or initial implementation until 2013.

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[5] Definition as developed by EUROCONTROL Safety Data Reporting & Data Flow (SAFREP) task force.

Early steps will also need to be taken with respect to ANSP and States enablers . The ANSPs have to conclude a cooperation agreement to start their cooperation and the States have to decide on a declaration of intent. Both are to agree on an implementation structure and on an implementation plan. The States have to develop of a common charging regime in close cooperation with the ANSPs. If enablers are not in place to at least make the first steps possible, this will limit the options for early implementation.

8 Human resources aspects of FAB initiatives

The implementation of FAB Europe Central will create possibilities for personal development both within existing roles, and within new roles beyond the individual organisations. The human resources impact of the implementation of the FAB will depend on the institutional scenario that will be chosen. Due to this fact, a proper change management and social dialogue process will be key contributors to the success of the implementation of any FABEC scenario

Cooperation within FAB Europe Central will also have consequences for the staff of the ANSPs involved. International cooperation to address the challenges of the future in one of the busiest areas of airspace in the world will provide clear opportunities but also challenges for all staff, but at the same time any institutional changes that will be made to implement the FAB will need to be acceptable to staff.

8.1 Challenges and opportunities for staff

The challenge of the FAB is clear: air traffic will continue to grow at a rapid pace and this traffic will need to be handled in a safe and expeditious manner. In previous sections, a number of initiatives have been described to make this possible, but the success of these initiatives for a large part depends also on the support of motivated and highly qualified staff.

A FAB implementation will include changes to technical and operational as well as support systems, providing an equal challenge to all staff. Common systems and procedures will promote harmonised working methods. Roles and responsibilities of staff will change, thereby creating opportunities to develop in a new environment.

In addition, the work environment will change in a FAB context. This includes a more international dimension being added to most functions, resulting in a different set of qualifications required from staff and new opportunities opening up through enhanced internationalisation. This includes new possibilities for personal development as the scope of the functions expands beyond national boundaries. Enhanced cooperation within the FABEC will generate a wider range of mobility opportunities.

The rate of change will be significant and success will depend upon the support and commitment of motivated and qualified staff.

The international environment of the FAB will open up a new direction for development for all staff, both in terms of opportunities provided beyond the current own, national organisation and company culture and in terms of the specific opportunities the operation and management of the FAB itself will make possible.

Good collaboration between staff and management of the service providers will be essential to successfully implement, and run, FAB Europe Central.

8.2 Human resources aspects of the different scenarios

The three scenarios (for cooperation models) considered in the feasibility study will involve a number of changes that will have different Human Resources impacts. These include staffing, working conditions, social dialogue, culture and change management, training and competence, and structure and leadership.

Contractual cooperation

In the contractual cooperation scenario, the ANSPs will remain completely independent organisations and as such, the impact of this scenario on existing roles and responsibilities is limited. As a result, staff acceptance and support for this scenario is expected to be high. The international aspect to some functions will be positive.

Benefits in this scenario could include:

- A higher job attractiveness for existing and new staff due to an international aspect added to the job profile
- Some benefits in staffing could be achieved in expert functions
- An increased intercultural awareness of staff due to growing internationalisation
- The possibility to set up a long term change management process

From a human resources point of view, implementing this scenario will create awareness for working together in FABEC. This awareness will create a good starting position and enable further steps.

Alliance

In an alliance, selected services/functions will be integrated in centralised units at FAB level.

Additional benefits in this scenario, beyond those listed for contractual cooperation, could include:

- Some staff synergies in the joint entities
- Common vacancy and employer marketing regarding job vacancies
- Common recruitment procedures (interviews, assessment centres etc.)
- Harmonised policies and procedures regarding working conditions

Setting up an effective social dialogue will support the implementation process.

If the alliance scenario leads to staff reductions in some functions or services, these reductions will need to take place in a socially acceptable manner: e.g. natural outflow, identification of other job possibilities, re-training of staff, early retirement scheme. This is essential to ensure acceptance by social partners, and related transitional costs must be considered carefully.

Single ANSP

In a single ANSP scenario, all ATS provision in the FAB will be integrated into a single organisation, with the possible exception of services not covered by the FAB cooperation such as tower services. With the integration of several organisations into one, reductions in staff can be expected, especially in some support and corporate functions.

Any staff reduction will again need to be achieved in a socially acceptable manner - this will be similar to but more pronounced than in the alliance scenario. The implementation costs of such a scenario should not be underestimated. Also to be considered are costs for potential upward harmonisation of the working conditions, changes to infrastructure, harmonisation of systems and training needs, etc.

Agreements with the social partners will be particularly important to make this scenario work, establishing the need to set up a FAB-wide social dialogue process as well as a change management process accompanying staff and organisation in the transition phase and beyond.

In a single ANSP there is a risk that any industrial action has a more significant impact on European ATS.

Besides some benefits mentioned in the other scenarios, the following ones can be expected from the single ANSP scenario:

- Synergies also outside specialist functions
- Uniform career paths allowing for more development opportunities

8.3 Summary of the assessment

The level of complexity in realising the three institutional scenarios is not equal and will increase when the level of integration increases. However, all three scenarios are feasible from a human resources point of view, provided direction is given on the institutional set-up and the organisational structure including the business concept. Established leadership throughout the organisations is required to get commitment to implement the intended changes.

The time needed and the benefits to be gained as well as the appropriate involvement of the social partners will vary significantly between scenarios and even between the different possibilities for the concrete manner in which a scenario is given form. The implementation of any of the scenarios should be aligned with a strategic direction, based on business needs.

Special consideration will need to be given to country-specific human resources aspects including national laws (which cannot be amended at the sole initiative of the ANSP) and the internal ANSP rules and practices. The specific HR aspects and the associated risks will need to be identified in a due diligence once a way forward has been decided.

Besides legal obligations and financial risks, soft factors such as cultural aspects, change management aspects including potential change resistance and staff interests need to be considered. Establishing a long term change management and social dialogue process are considered as key contributors to the success of the implementation of any FABEC scenario.

9 Performance evaluation of the cooperation

The results of the performance evaluation show that the identified FAB initiatives will provide a significant contribution to achieving the targets: Targets on capacity, cost effectiveness and environmental impact will be met. In addition, the long term target on flight efficiency will be met and even exceeded, but the short term target will not be met through FAB initiatives. In regard to safety, the experts are confident that the FABEC based on the operational concept can be made sufficiently safe. In regard to the military mission effectiveness further studies are necessary.

This section presents the results of the performance evaluation of the FAB proposals. The evaluation takes into account a combination of the identified areas of cooperation and roadmap (Section 5) and the cooperation models (Section 6).

The performance targets for FABEC were provided in Section 2.3, and are repeated here as reference:

- The FABEC development shall take all efforts necessary to **ensure an improved safety level**. This means that, despite the civil traffic growth the current absolute number of ANS induced accidents and risk bearing incidents shall not increase or will even decrease.
- The FABEC development shall contribute to **reduce the impact on environment** by improvements of routes, flight profiles and distances flown.
- **Develop the airspace capacity so as to meet the demand** of increased civil air traffic in the range of 50% for 2018 based on EUROCONTROL STATFOR forecasts, taking into account the current agreed delay target of 1 minute per flight and taking into account the military needs.
- Within FABEC **the expected 50% increase of civil traffic by 2018 shall not result in more than 25% increase of total cost** based on current rules of cost recovery (leading to a 17% reduction of the real en-route unit cost). On the military side, a decrease in ATM cost shall be realised.
- The FABEC development shall **significantly contribute to improve the flight efficiency** by improvements of routes, flight profiles and distances flown. In 2006 the average extension of flights in the EUROCONTROL area related to the Great Circle distance has been around 48 km. The target will be a reduction in the FABEC area in the average route extension of two kilometres per annum until 2010, increasing to an accumulated total of 10 km by 2018.
- The FAB EC development shall **significantly contribute to improvement of military mission effectiveness by improvements of training capabilities and readiness postures as required by States**.

9.1 Safety feasibility indication

Considering the early stage of development of the FABEC, a full Safety Case cannot yet be delivered. Instead, the project has produced a 'Safety Feasibility Indication', giving an indication of the likelihood of meeting the overall safety objective once the FAB has been designed. It is expected that during the implementation of the FAB an overall Safety Case for the activities could be completed once they are defined in more detail. The established safety objective already points towards improved safety levels in the future FAB environment:

> *"The overall safety objective is that the operations after implementation of the FAB should be safer than current operations, in the sense that the number of accidents and risk bearing incidents per year that are in some way related to ATM should not increase. In the context of the assumed traffic growth of 40 to 50%, this means that the safety level per movement should increase".*

The hazards related to the common operational concept have been assessed and for most of them, sufficient feasible and effective potential remedies have already been identified. A small number of issues[6] have been identified which would require further research and development should the FAB be implemented:

- Communication and surveillance problems with UAVs
- Autonomous aircraft operations
- Communication problems regarding dynamic sectorisation
- Interception of civil aircraft with a communication failure by military jets
- Emergency descents

Evidence that these issues can or cannot be solved could not yet be identified. If these issues can be addressed and all safety requirements are fulfilled, then there is **justified, expert-based confidence that a FAB based on the common operational concept can be made sufficiently safe** to comply with the FAB's overall safety objective. Further details on the assessment performed within the context of the safety study are provided in Annex E.

9.2 Operational performance analysis

The operational performance of the FABEC region has been analysed, firstly to assess the operational performance if FABEC is not implemented. This provides a reference case to assess the incremental benefits of the FABEC initiatives. The analysis presents the performance of the FABEC region at three points in time: 2009, 2013 and 2018. The analysis presents the results of the following performance areas:

- Traffic
- Capacity
- Punctuality, predictability and flexibility
- Flight efficiency
- Environment

[6] It should be noted that a number of these issues are likely to exist even without the formation of the FAB and will therefore need to be addressed by the ANSPs anyway.

The analysis of each of these performance areas is presented in the following sections.

9.2.1 Traffic

In 2006, the FABEC ANSPs controlled 5.3 million flights with a total of 3.9 million flight hours controlled. Traffic levels are forecast to increase considerably over the coming years. By 2009, the traffic forecast estimates that there will be between 4.2 million and 4.4 million flight hours controlled; an average increase of between 2.3% and 3.9% per year.

After 2009, the rate of growth is forecast to be marginally reduced. By 2018, the traffic forecast estimates that there will be between approximately 5.1 million and 5.7 million flight hours controlled.

Figure 23 presents the traffic forecast from 2006 to 2018.

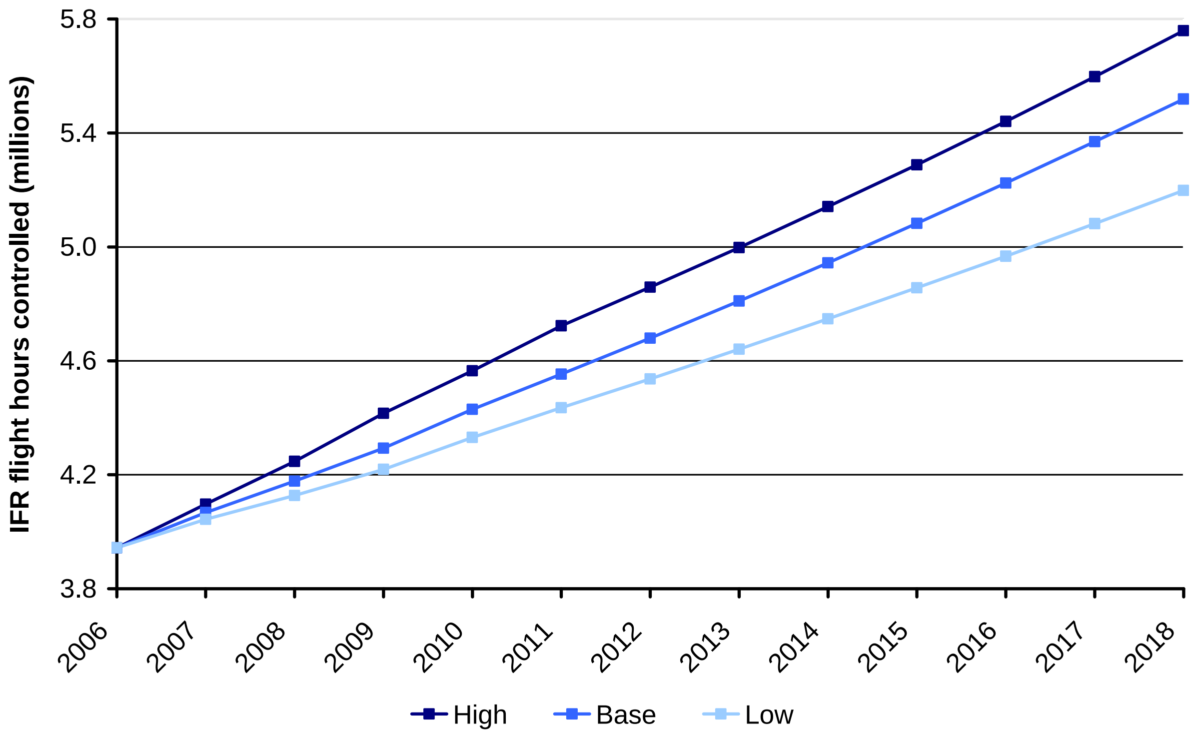

Figure 23 Traffic forecast (2006 to 2018)

The demand for air transport is expected to continue increasing for the foreseeable future. By 2018 the level of traffic is expected increase by between 32% and 47% higher than in 2006.

9.2.2 Capacity

The short term capacity plans of the ANSPs are described in the Local Convergence and Implementation Plans (LCIPs) for 2008 to 2012, for each State. Even without the implementation of FABEC the LCIPs show that all ATC units within the FABEC region plan to provide up to 30% additional capacity (peak hourly capacity for flights entering the ATC unit) by the end of the LCIP period (2012). It is assumed that the increases in capacity proposed between 2008 and 2012 will continue until at least 2013.

After 2013, most major sources of capacity improvements will have been exhausted, with only minor improvements possible on an annual basis (approximately 2% per year), except for Karlsruhe, where relatively low capacity growth during the previous years and the implementation of the new ATM system will lead to a slightly higher rate of growth (approximately 3% per year).

The FABEC initiatives have considerable capacity benefits. By 2013, the Operational Concept is expected to provide an additional 3% - 5% capacity, depending on the region observed. The early FAB initiatives focus on the core area (otherwise known as ‘hotspots’), resulting in the largest benefits in these areas. By 2013, the resectorisation of these ‘hotspot’ areas is also expected to provide an additional 2% - 5% capacity in the core area, depending on the region observed. Throughout FABEC, and depending on location, ATC units are expected to increase total capacity by between 3% and 10% by 2013, due to the FABEC initiatives.

Figure 24 shows the medium term capacity benefits in areas excluding UACs. Figure 25 presents the same analysis as Figure 24 but includes the capacity benefits at the UACs in FABEC (Maastricht, Karlsruhe, Zurich and Geneva), where appropriate.

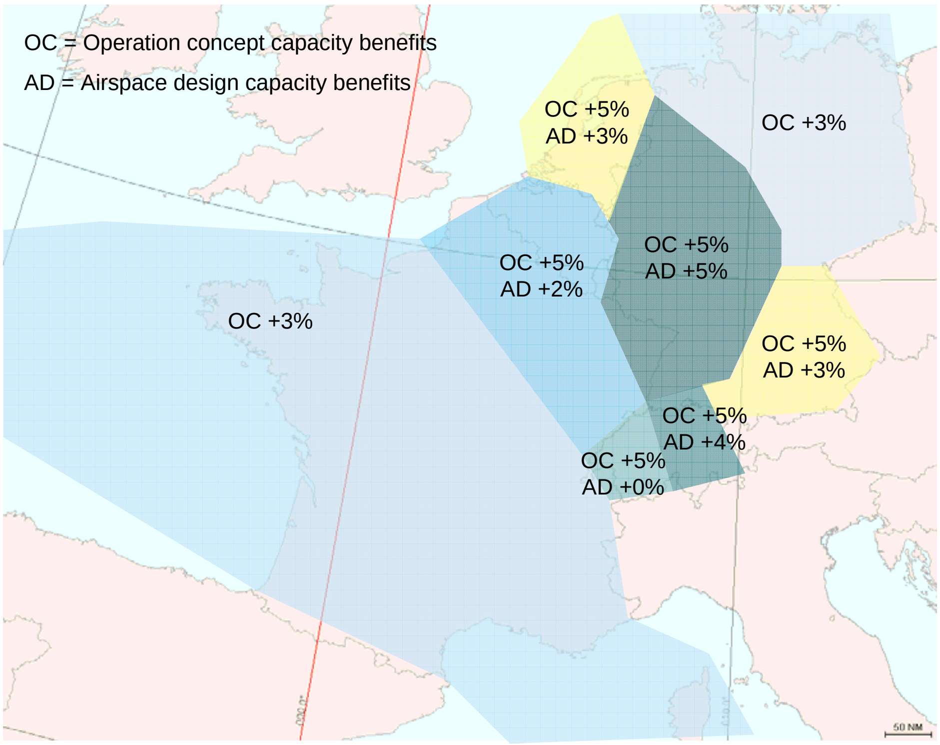

Figure 24 Additional capacity increases from FAB initiatives in 2013 (excluding UACs)

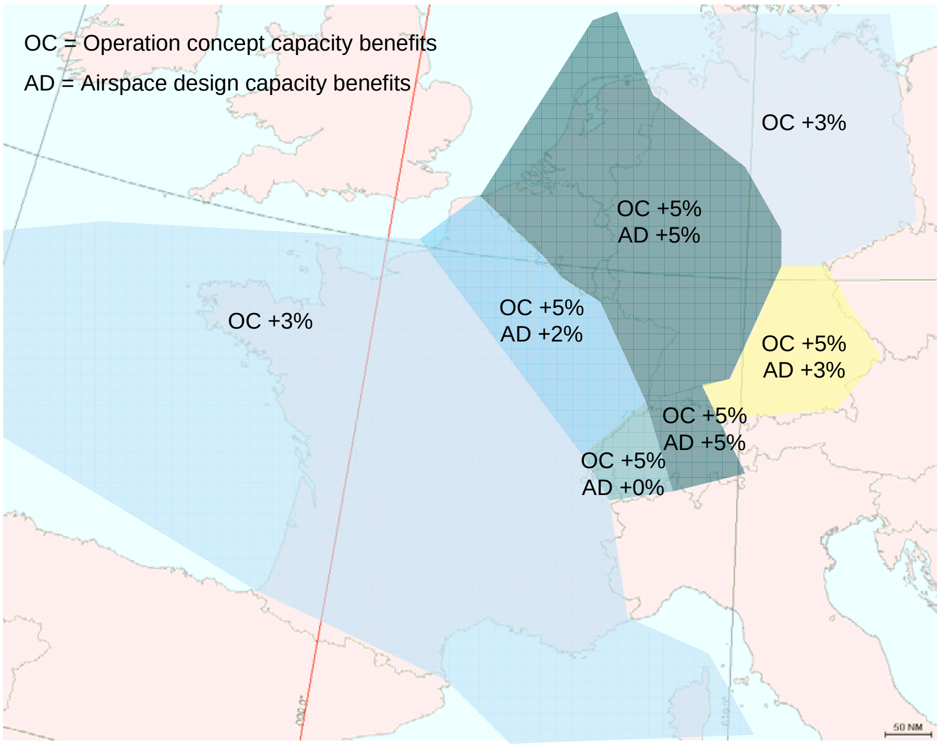

Figure 25 Additional capacity increases from FAB initiatives in 2013 (including UACs)

By 2018, further implementation of the Operational Concept and airspace design initiatives are expected to provide between 15% and 17% of additional capacity, depending on location. The analysis has also shown that there may be an additional 10% capacity increase in the longer term. Provided that all components of the Operational Concept and the airspace design initiatives are implemented then this increase can be translated into improved ATCO productivity rather than further reducing the level of delay.

Figure 26 presents the estimated capacity benefits from the operational concept in 2018. UACs are included as the benefits are not expected to depend significantly on flight level.

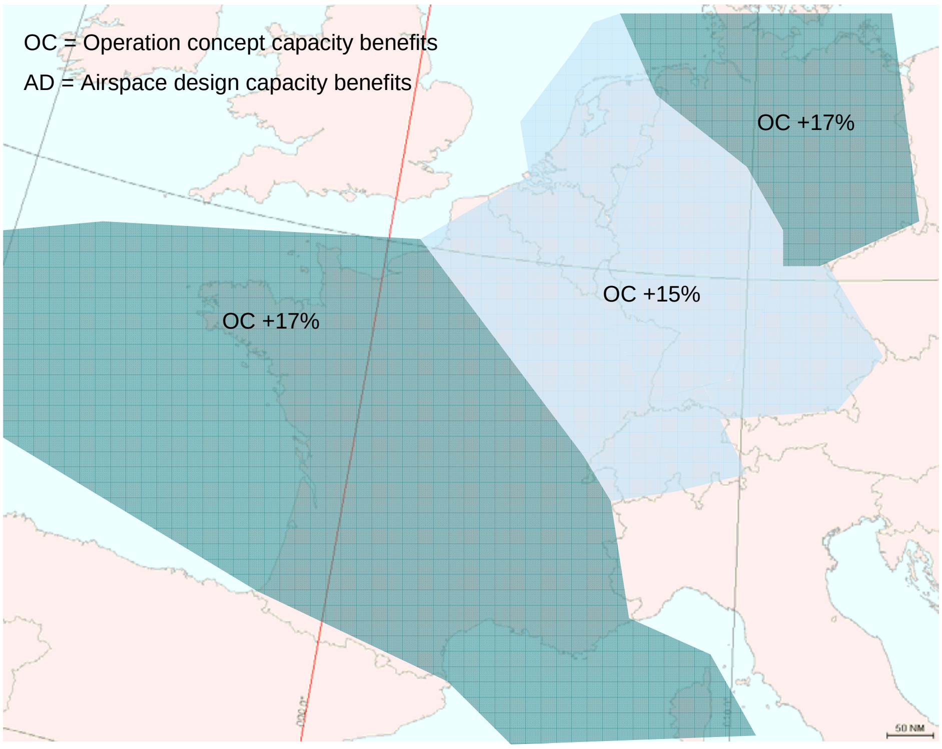

Figure 26 Additional capacity increases from FAB initiatives in 2018

In conclusion, it is expected that the FABEC initiatives will lead to a capacity increase of 20% to 25% depending on the region of the FAB. This capacity increase is in addition to the plans the ANSPs have to increase capacity without the implementation of FABEC. **The combination of existing and FAB initiatives will be sufficient to handle traffic levels in 2018.**

9.2.3 Delay

If the level of traffic demand exceeds the available capacity of a region of airspace then delay is generated. The Provisional Council has set a target that within European airspace the amount of en-route ATFM generated delay should not exceed an average of one minute per flight during the summer months (May - October). In 2006 and 2007 this target was not achieved.

The amount of en-route ATFM delay generated in the FABEC region is forecast to grow over the coming years. Simulations performed show that by 2009, a peak week during the summer could generate 2.4 minutes average delay per flight. This simulation estimated the delay due to ATC capacity related causes and excluded delay causes such as weather and special events. By 2013 this figure is estimated to rise to 2.7 minutes average delay per flight and by 2018 it could be as high as 5.5 minutes average delay per flight. It should be noted that this is for a peak week in the summer and hence the annual en-route ATFM delay per flight is likely to be considerably less, however such high delay figures are likely to cause considerable disruption to the ATM network. In fact, it is unlikely that ANSPs and airlines will allow the situation to degrade to this position and will likely implement other measures (further investment or demand management) to mitigate the negative impact of such delays.

The simulations have also shown that the capacity increases from the FAB initiatives will have a considerable impact on the level of delay. In 2009, there will not be any major initiatives implemented although there could be some improvements that may reduce the average level of delay from 2.4 minutes per flight. By 2013, it is estimated that the FAB initiatives will reduce the average delay from 2.7 minutes per flight to 0.3 minutes per flight and by 2018 average delay is estimated to have further reduced to 0.1 minutes per flight. These figures assume that the majority of the expected performance improvements are used to increase capacity and reduce delay, rather than reducing costs for the ANSP. In cooperation with airspace users ANSPs may decide to accept a higher but still acceptable level of delay and reduce the cost of providing the service.

The increased capacity provided by the FAB initiatives will also reduce both the percentage of flights that are delayed and also the average delay per delayed flight, improving punctuality and predictability for airspace users. **By 2018 it is estimated that the percentage of flights delayed by ATFM regulations will decrease from 33% without the FAB to 1% with FABEC implemented, with the average delay per delayed flight reducing from 17 to 6 minutes of delay per flight.**

The reduced delays and the increased punctuality and predictability afforded by the performance improvements of FABEC are likely to provide significant benefits to the airspace users. The capacity increases that are expected to be achievable will reduce ATFM delay to extremely low levels. Such levels may be considered too low by ANSPs and airspace users, and hence a trade off between a slightly higher level of delay and reduced costs may be accepted.

9.2.4 Flight efficiency

The performance analysis has shown that without the FAB the horizontal flight efficiency within the FABEC region is likely to worsen. By 2018 it is estimated that the direct route extension (the difference between the shortest route between TMA exit and entry points and the actual route flown) will be 6.1% of the distance flown.

The FAB initiatives are estimated to improve flight efficiency through providing more direct routings and an improved route network. The common operational concept, through the introduction of 4-D trajectory management and improved ATFCM will help to ensure that flight efficiency is optimised.

The flight efficiency simulations that have been performed provide a maximum theoretical benefit from the FABEC initiatives. By 2018, the simulations show that the maximum possible benefit could bring a 2.7% improvement in flight efficiency compared to the 2018 reference case, which is equivalent to a reduction of 29 kilometres per flight. **In comparison to the present situation, the reduction of average route extensions in FABEC in 2018 is 17.4km.** These figures are considered to be a maximum; it is likely that the actual benefit achieved will be lower.

9.2.5 Environment

The impact of sub-optimal flight efficiency on the environment has also been simulated. The simulations have shown that by 2018 and without the FAB direct route extension could result in each flight burning an extra 260kg of fuel on average, resulting in an additional 816kg of CO_2 and 2.5kg of NO_x being emitted per flight.

The fuel burn and emissions simulations that have been performed provide a maximum theoretical benefit from the FABEC initiatives. The simulations have shown that with the FAB initiatives additional fuel per flight due to direct route extension would be reduced from 260kg to 139kg per flight, with CO_2 emissions falling to 438kg per flight and NO_x emissions falling to 1.3kg per flight due to the reduction in direct route extension.

The impact of sub-optimal flight efficiency on the environment was foreseen to worsen in the reference case. **The FAB initiatives will improve flight efficiency markedly and hence its impact on the environment.**

9.3 Cost-benefit analysis

A cost-benefit analysis for the FABEC project has been undertaken. It draws on the conclusions of the working groups and other stakeholder representatives concerning the possible beneficial cooperative initiatives that may be taken as part of FABEC. This section provides a summary of the CBA that was performed in the context of the feasibility study; further details are provided in Annex F.

A cost-benefit analysis should reflect costs and benefits to all parties. In the case of the FABEC, the relevant parties comprise:

- Air navigation service providers in the FABEC States, both civil and military
- Airspace users, of the airspace in the FABEC States, both civil and military
- The administrative apparatus of the States
- Consumers of air transport (passengers and freight customers)
- The general public (who are affected by environmental and safety costs and benefits)

In practice, available information has meant that the quantitative part of the analysis has been confined to civil ANSPs and civil airspace users. These are likely however to comprise the vast majority of the impacts of the project. Impacts on military users, military service providers, and State administrations are considered qualitatively; and the impact on consumers of air transport is considered to be subsumed in that on commercial airspace users.

The benefits considered quantitatively in the cost-benefit analysis therefore comprised:

- Benefits that accrue directly to airspace users, including:
    - Benefits from reduced delay, as ANSPs can provide increased capacity
    - A reduction in unaccommodated demand, arising from the same cause
    - Benefits in terms of improved horizontal flight efficiency; a reduction in the excess distance flown
- Benefits that accrue initially to the ANSPs, and are then passed through to airspace users, arising from a net reduction in costs to ANSPs

9.3.1 The reference case

A key element of any cost-benefit analysis is a ‘reference case’. This should be a realistic assessment of what the future scenario would be in the absence of the project. In the case of FABEC, this is the situation in which cooperation between ANSPs continues at similar levels to those in the past.

The reference case for FABEC is based, in the period to 2012, on ANSPs’ plans, and in the longer term, to 2025, on extrapolation and plausible assumptions about the development of key performance parameters such as ATCO productivity and wage rates, in the absence of the FAB. This reference case shows a long term improvement in en-route financial cost effectiveness, reaching 9% by 2018. This long term improvement in financial cost effectiveness is offset by a decline in the quality of service provided, through increases in delay and unaccommodated demand, and a reduction in flight efficiency.

9.3.2 The FABEC initiatives

A wide range of cooperative initiatives in the FABEC, as described in Section 5, were considered and their impact quantified:

- Improvements to the operational concept and associated improvements to airspace design, as described in the previous section on operational performance analysis
- Improved ATM infrastructure and related technical support, producing cost savings through convergence on common ATM systems, and through common procurement
- Improved CNS infrastructure and related support, producing cost savings through joint planning, procurement, and provision
- Common training and qualification of personnel, producing cost savings
- A more cost-effective way of providing the level of contingency coverage specified by the States as their collective response to the requirement of the SES, producing cost savings
- A cooperative approach to the provision of AIS, producing cost savings
- An improved more cost-effective way of using and sharing MET information, resulting in the reduction of weather-related delays
- A single charging zone and single unit rate in the FABEC airspace, this would remove incentives to use longer routes to minimise route charges, therefore improving flight efficiency, but more importantly it is a prerequisite for obtaining the benefits from ANSP cooperation, since the cost pooling inherent in a single charging zone will remove incentives for ANSPs to compete for traffic

The focus of the cost-benefit analysis was on the alliance institutional model, in which a structure of contracts between ANSPs is supplemented with some joint decision making bodies in key areas. It was considered that achievement of this level of benefits was also possible within a purely contractual institutional model, but that such a model was likely to take substantially longer to achieve the benefits, and there were increased risks of failure to achieve them.

In addition, some other, ‘more ambitious’ initiatives were considered that were likely not to be achievable without closer institutional models of the ‘single ANSP’ type – such initiatives comprised:

- Closer cooperation on the provision of ATM infrastructure, not ruling out possible net cost savings from reduction in the number of operating units
- Reduction in some elements of central overheads

It was recognised that substantial transition costs might be associated with such moves, as well as pressures to increase levels of costs caused by merging organisations.

Some further impacts were not quantified, including:

- The impact of improved vertical flight efficiency, predictability and punctuality (over and above the impact from delay reductions and the reduction of unaccommodated demand)
- The costs to military users of re-locating their training areas

- The benefits to the military of improved civil/military and military/military coordination that might be brought about by ambitious models of cooperative civil/military service provision
- The impacts on States' administrative and regulatory apparatus, where short term costs arising from the change might be followed by long term benefits in coordinated and cooperative approaches to regulation

For each FABEC initiative, the likely magnitude and timing of the benefits was assessed. An assessment of the transition costs was also made, including the required set-up costs, training costs, and the investment required to bring the initiatives about.

9.3.3 The scenarios considered

The reference case was compared with two 'FAB cases'. One corresponds to those initiatives that are achievable in the contractual cooperation and alliance models (it is argued that the initiatives achievable are the same, although greater risks, especially of extended timescales, are thought to be associated with the contractual model); a third, more ambitious scenario, includes extra initiatives that could only be accomplished with closer institutional cooperation under the single ANSP model.

9.3.4 The results

The analysis shows, on the assumptions made for the alliance scenario, that the corresponding FABEC initiatives will bring substantial benefits. These benefits comprise the operational benefits discussed in the section on the operational performance analysis, and saved ANSP costs will be added.

The detailed outcome of a number of major FAB initiatives could be taken either as reduced delay, through providing more capacity; or as reduced costs. The base case considered here uses the assumption that the FAB as a whole aims for an average delay of 0.5 minutes per flight. This target is believed to be consistent with the Provisional Council's target of 1 minute per flight, since the latter target is for summer, when delays are generally greater, and applies to Europe as a whole rather than just FABEC. The consequences of aiming for a less ambitious delay target have been examined: aiming for a target in the FAB of 0.75 minutes delay per flight results in a major shift of benefits from delay savings to cost savings. The overall benefits of the project are, however, substantially lower.

The FAB initiatives help to reduce the costs of service provision compared to the reference case, resulting in improved financial cost effectiveness. The FAB initiatives also remedy the decline in economic cost effectiveness that is foreseen in the reference case by maintaining a high quality of service, through a decrease in delay, a reduction in unaccommodated demand, and an increase in flight efficiency.

The results of a cost-benefit analysis are conventionally presented as a discounted cash flow. This takes into account the relative value of present and future costs and benefits by using a 'discount rate'; the value of equivalent benefits one year later are reduced by the discount rate.

The discounted cash flow calculation sums the net benefits of the project over its history, with costs and benefits in each successive year appropriately discounted. The Net Present Value (NPV) of the project is the sum of these discounted cash flows for the life of the project.

Table 8 presents the NPVs of the project cash flows taking into account net benefits to a number of time horizons. For each horizon, the following results are presented:

- The present value (PV) of the direct user benefits - the savings in delays and flight efficiency gains

- The net present value (NPV) of the ANSPs' cash flow
- The sum of these - the NPV of the project as a whole

	Direct benefits (PV)	NPV of ANSPs' cash flow	Project NPV
2014	€ 376m	€ 195m	€ 571m
2020	€ 3,147m	€ 685m	€ 3,832m
2025	€ 6,196m	€ 1,099m	€ 7,295m

Table 8 Present value of FAB initiatives

The nature of contractual cooperation is expected to increase the risk of delaying the implementation of the FAB initiatives. This delay is likely to be due to the requirement to refer individual decisions regarding the FAB initiatives to each ANSP for agreement. Such a process may result in lengthy delays to implementation which could impact in the following ways:

- Increased project risk
- Increased time taken to implement initiatives
- Increased implementation costs
- Achieving the benefits will be delayed

The more ambitious single ANSP scenario is likely to yield greater benefits, with the extra benefits concentrated in the area of cost reduction for ANSPs. However, achieving the benefits of the more ambitious scenario is likely to involve much longer timescales, much greater transition costs (particularly in terms of new investments and social costs), and to have a greater degree of risk.

9.3.5 Sensitivity analysis

The sensitivity of the results of the cost-benefit analysis to input variables was undertaken. The variables investigated were:

- Capacity growth after 2012 corresponding to the pessimistic capacity growth scenario
- Traffic demand being lower than anticipated
- Uncertainty in the benefits of the operational and technical initiatives
- The impact of the ATFM delay target on the NPV
- The impact of the discount rate on the NPV

The results are sensitive to the input parameters, but the NPV remains positive and substantial in all cases. The results are most sensitive to the level of delay which is generated in the reference case. The analysis has shown that the FAB initiatives will overcome the capacity constraints, however the scale of the benefits and to whom the benefits are apportioned is most sensitive to the rate of traffic growth and also the magnitude of the capacity constraints foreseen in the reference case.

The sensitivity analysis has shown that in 2025 the NPV for the FABEC project could range from €3,600m to € 9,800m, with the NPV most likely to be in the region of €7,000m.

9.4 Summary of performance

In terms of the targets that were defined by the ANSPs, the performance of the FABEC proposal can be summarised as follows:

- The study has concluded that there is justified, expert-based confidence that a FAB based on the defined common operational concept can be made sufficiently safe to comply with the FAB's overall safety objective.
- The target for flight efficiency for 2018 can be met and will probably even be exceeded. In the optimal situation, average flight extension will be as low as 19.2NM per flight, compared to 28.6NM today and to an expected 34.8NM per flight if FABEC is not implemented. It is important to note that the figure of 19.2NM is dependent on assumptions on a number of subjects for which it is at this moment difficult to judge how they will develop and therefore actual improvement could be slightly less. This should however be considered in relation to a considerable decrease in flight efficiency in the case without FABEC implementation.

  The improvement up to 2010 that has been defined in the target will not be achieved through FAB initiatives, as these will not take effect in the next 2 years.
- Due to improved flight efficiency, the emissions of air traffic will be lower with implementation of FABEC than they would be otherwise. Therefore, FABEC development will contribute to reduction of impact of air traffic on the environment.
- Sufficient capacity can be made available to meet traffic demand in 2018, whilst keeping average delays below 1 minute per flight. This will require a combination of existing short term initiatives outside the FAB development and medium to long term FAB initiatives (common operational concept, airspace design).
- Expected reduction in unit cost is approximately 17%, therefore the target will be met. This improvement should be seen in combination with high quality of service (in terms of capacity and flight efficiency).
- Airspace use by both civil and military users has been taken into account in the definition of the common operational concept (in particular through the implementation of all FUA elements) and airspace design, with the aim of providing improvement. To bring the expected benefits it is paramount to fully implement the operational concept and airspace design including legal solution to facilitate cross-border operations.

SECTION IV: CONCLUSIONS

10 Conclusions

This study shows that a Functional Airspace Block Europe Central is not only ***feasible*** *– cooperation is* ***necessary*** *to meet the challenges of the expected growing traffic in the next year. To enable an effective implementation of the identified areas of cooperation in line with the roadmap, the States will have to address a number of measures in the field of legislation and regulation. Due to the fact that the negotiation and ratification of a Treaty needs time and that there are still a few of activities which can be taken by the ANSPs immediately a joint but parallel approach is required. Therefore the experts recommend to start a ANSP cooperation immediately in areas where no Treaty is needed. In addition, further consultation of stakeholders including social dialogue is seen as a key contributor for a successful implementation.*

The detailed feasibility study has provided an ambitious set of initiatives to respond to this framework, taking into account the contributions from all relevant partners: States, civil and military ANSPs. If implemented, these initiatives will make a significant contribution towards the goals of the Single European Sky as the airspace will increasingly become a continuum for its users.

When analysing the performance targets we can conclude the following:

- It is too early for a detailed safety case of FABEC. Initial analysis of **safety** shows that there is confidence that the FAB, based on the common operational concept that was defined within the study, can be made sufficiently safe. The safety of FAB operations will be enhanced through a cooperative approach to safety management, enabling sharing of best practices and lessons learned as well as a coordinated way forward on addressing safety issues.
- Implementation of the operational initiatives (operational concept and airspace design), supported as applicable by other areas such as technical systems, training, charging, etc., will deliver significant improvements in **capacity** and **flight efficiency**. Only addressing the issues in the core area of Europe at a FAB-wide scale will allow the optimisation of the use of the available airspace - both in terms of organisation of the airspace and operations within the airspace. In this sense, cooperation between civil and military partners is paramount.
- Improvements in flight efficiency will have a direct relation to reducing **environmental impact**: every km reduction in distance flown leads to a reduction in fuel burnt and therefore a reduction in emissions per flight.
- Cooperation at FAB level will deliver benefits in terms of **cost effectiveness** due to ANSP cost savings as a result of reduced fragmentation and increased productivity. The benefit for the airspace user should be seen as a combination of direct and indirect cost savings: indirect benefits for the users will occur through ANSP cost savings as a result of for example cooperation on training and convergence of technical systems; direct savings for the users will be achieved through high quality of service leading to the avoidance of potentially high delay and flight inefficiency costs

that would occur without FABEC. This combination, the economic cost effectiveness, will bring significant benefits to the users.

- To increase **mission effectiveness**, measures to improve airspace use by both civil and military users have been taken into account as an integral part of common operational concept (in particular through the implementation of all FUA elements) and airspace design. To bring the expected benefits it is paramount to fully implement the operational concept and airspace design including legal solution to facilitate cross-border operations.

The performance is based on a number of areas of cooperation that are expected to bring benefits in the FABEC area. In particular, a **common operational concept** has been agreed and a **future airspace design** developed for use in the feasibility study. The main objective of the FAB is considered to be to deliver the benefits both can bring, through cooperation in areas of **operations, safety, technical systems and services, training and the charging scheme**. Potential cooperation in the areas of AIS, MET and contingency concepts has been identified, but this will require decisions on the way forward before details can be developed.

The evolution of the cooperation has been developed into a consolidated FABEC roadmap. The leading element of the roadmap is the operational concept. Closely related to this are the airspace design developments and the technical roadmap. The roadmap covers the period from the present to 2018 and beyond, and includes early steps to deliver benefits in the short term.

The **institutional** form of the FAB is an important subject that has been considered in the feasibility study. The institutional form in service provision can develop through a stepwise growing level of cooperation, starting with contractual cooperation. For the medium and long term 2 more advanced models for use by civil and military partners, integration into an alliance and consolidation into a single ANSP, were also studied. The single ANSP model might be a necessary enabler for the full operational improvements, but this requires further study. Involvement of military partners in the different institutional models of cooperation will require decisions at national level. However, in general, military partners have recognised that in a number of areas win-win situations are more realistic in stronger cooperation models.

Specific attention will need to be given to social issues during the transitional period in which the FAB and its institutional form are taking shape. Taking due account of national aspects (ranging from legal obligations at a national level to softer factors such as cultural aspects) in this phase will be required. A social dialogue process at FAB level will need to be set up. It is clear that if properly managed, FABEC can offer new opportunities and an attractive future to its staff. The continued support of staff is essential when implementing the FABEC project.

Implementation of FABEC puts requirements on **States** to address a number of issues in the areas of harmonisation of rules, regulation and regulatory oversight.

The development of FAB Europe Central will take fully into account the interfaces with its neighbours in terms of airspace design and the route network, flow management, information management, interoperability, etc. This will ensure enhancement of performance of the region beyond the borders of the FABEC States. During the feasibility study, a number of coordination meetings were already held with neighbouring FABs, and the UK has been involved in the feasibility study as cooperative partner.

Overall, the feasibility study has delivered concepts, proposals and analysis in many different areas. The detail of the study varies between subjects, depending on parameters such as timescale, existing experience and familiarity with the subject and size of proposed changes. A clearer view is possible on subjects which are relevant for the short term future, which are related to well-known areas and/or which require only minor changes to the existing situation. With the feasibility study completed, some subjects require definition of initial implementation steps, some require further study, and some still require determination of the preferred option. There is also a requirement to further align the deliverables stemming from different work streams. Many challenges remain ahead and the success of the next phase depends on the strong commitment received from all partners involved.

In summary, benefits will be delivered through cooperation within the FAB that are not or only partially achievable without cooperation. FABEC is required to meet the performance framework that has been defined for the core area of Europe. The FABEC detailed feasibility study has shown that the implementation of the Functional Airspace Block Europe Central is **feasible** and **necessary**.

ANNEXES

A References

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B Acronyms

AAS	Advanced Airspace Scheme
ACC	Area Control Centre
ACE	ATM Cost Effectiveness
AIS	Aeronautical Information Services
AMAN/DMAN	Arrival Manager/Departure Manager
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
APP	Approach Control
ARO	ATS (Air Traffic Services) Reporting Office
ARTAS	ATC Radar Tracker and Server
ARTS	Automated Radar Terminal System
ASM	Airspace Management
ASS	Assessor
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCEUC	Air Traffic Controllers European Unions Coordination
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATS	Air Traffic Service
ATSEP	Air Traffic Services Engineering Personnel
AUP	Airspace Use Plan
BAF	Belgian Air Force
CBA	Cost-benefit Analysis
CBT	Computer Based Training
CCC	Common Core Content
CDM	Collaborative Decision Making
CDR	Conditional Route
CEO	Chief Executive Officer
cFLAS	contingency Flight Level Allocation Scheme
CFMU	Central Flow Management Unit
CNS	Communications, Navigation and Surveillance
CRCO	Central Route Charges Office
CT	Continuation Training
CWP	Controller Working Position
DFS	Deutsche Flugsicherung

DME	Distance Measuring Equipment
DMEAN	Dynamic Management of the European Airspace Network
DSNA	Direction des Services de la Navigation Aérienne
DT	Development Training
DWD	Deutscher Wetterdienst
EAD	European AIS Database
eAIP	electronic Aeronautical Information Publication
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
ECAC	European Civil Aviation Conference
ESARR	EUROCONTROL Safety Regulation Requirements
ETF	European Transport Workers' Federation
EU	European Union
EXM	Examiner
FAB	Functional Airspace Block
FABEC	FAB Europe Central
FDP	Flight Data Processing
FDPS	Flight Data Processing System
FHA	Functional Hazard Analysis
FIR	Flight Information Region
FRS	Fixed Route System
FUA	Flexible Use of Airspace
GAF	German Air Force
GAT	General Air Traffic
GND	Ground level
HLG	High Level Group
HLPG	High Level Policy Group
HMI	Human Machine Interface
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFATCA	International Federation of Air Traffic Controllers' Associations
IFATSEA	International Federation of Air Traffic Safety Electronic Associations
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IO	International Organisation
IPC	International Public Corporation
IT	Initial Training
KPI	Key Performance Indicator

LAA	Luxembourg Airport Authority
LCIP	Local Convergence and Implementation Plan
LVNL	Luchtverkeersleiding Nederland
MET	Meteorological Support Service
METSP	MET Service Provider
MIP	Main Implementation Package
MOC	Main Operational Change
MoD	Ministry of Defence
MoT	Ministry of Transport
MUAC	EUROCONTROL Maastricht Upper Area Control Centre
NOF	International NOTAM Office
NOP	Network Operations Plan
NPV	Net Present Value
NSA	National Supervisory Authority
OAT	Operational Air Traffic
OJT	On-the-job Training
OJT-I	On-the-job Training Instructor
OLDI	On-Line Data Interchange
OP	Operations Plan
PMO	Project Management Office
PRC	Performance Review Commission
PRR	Performance Review Report
PRU	Performance Review Unit
PSSA	Preliminary System Safety Assessment
R&D	Research and Development
RMCDE	Radar Message Conversion and Distribution Equipment
RNLAF	Royal Netherlands Air Force
RTS	Real-Time Simulation
SAAM	System for traffic Assignment & Analysis at Macroscopic level
SAM	Safety Assessment Methodology
SCM	Sector Configuration Management
SDP	Surveillance Data Processing
SES	Single European Sky
SESAR	Single European Sky ATM Research
SG	Steering Group
SID/STAR	Standard Instrument Departure/Standard Arrival Route
SMS	Safety Management System
SSA	System Safety Assessment
STATFOR	EUROCONTROL Statistical Forecast

SUP	Supervisor
SUR	Surveillance
SWIM	System Wide Information Management
TAAM	Total Airspace and Airport Modeller
TMA	Terminal Manoeuvring Area
TRA	Temporary Reserved Airspace
TRS	Tailored Route System
TWR	Tower Control
UAC	Upper Area Control Centre
UAV	Unmanned Aerial Vehicle
UIR	Upper Information Region
UT	Unit Training
VAT	Value Added Tax
VCS	Voice Communication System
WG	Working Group

C Consultation process

C.1 The audience

The audience for the feasibility study comprises - besides the participating organisations - three main groups:

- Customers/users
- Staff, including staff representatives
- External stakeholders

Table 9 below shows the detailed categories of stakeholders per group.

Stakeholder group	Organisations
Customers / users	▪ Airlines ▪ Other airspace users, including military and general aviation ▪ Airline organisations: AEA (Association of European Airlines), EBAA (European Business Aircraft Association), ELFAA (European Low Fare Airlines Association), ERA (European Regional Airline Association), IACA (International Air Charters Association), IATA (International Air Transport Association), BARIG (Board of Airlines Representatives in Germany) etc. ▪ Pilot organisations: AOPA (Aircraft Owner & Pilot Association), IFALPA (International Federation of Airline Pilot Associations) etc. ▪ Airports and airport organisations: ACI (Airport Council International Europe) etc.
Staff, including staff representatives	▪ Unions: local unions, ETF, ATCEUC etc. ▪ Guilds: local guilds, IFATCA, IFATSEA etc.
External stakeholders	▪ EUROCONTROL ▪ European Commission ▪ Neighbouring States (ANSPs, DGCAs) ▪ Regulators ▪ CNS and meteorological service providers ▪ Industry: members of the Industry Consultation Body (ICB) ▪ CANSO ▪ Media

Table 9 FABEC audience

C.2 Customer consultation

C.2.1 Principles and responsibilities

Communication and consultation were divided into two processes:

1. Important milestones: communicated via commonly organised international events (e.g. User Workshops, Stakeholder Forums). Target groups are all customers (full plenum). These events are organised at project level by the Communication WG.

2. Intermediate steps: communicated by all national ANSPs (individual responsibility) to their main customers (bi-directional). Any events and media are organised by each Customer Relations Manager.

C.2.2 Objectives

The objectives of customer consultation were the following:

- In-time and target-group oriented information of all customer groups, especially about benefit, background and interdependencies of the FABEC study
- Receive feedback from customers
- Increase general acceptance and support by the customers
- Evaluation of customer requirements
- Support of the Working Groups with providing customer requirements to the Working Groups
- Create transparency concerning planning and progress of the project

C.3 Staff consultation

As part of the social dialogue process of the FABEC feasibility study, a number of meetings with staff organisations were organised to inform them on the progress of the FABEC feasibility study and to allow staff organisations to provide their views. Participants of these meeting were the chairmen of the FABEC Working Groups and European staff organisations (ETF, ATCEUC, IFATSEA and IFATCA). National staff organisations were kept informed on FABEC developments through existing national social dialogue processes.

C.4 Standards

For communication and consultation purposes, several standards were created:

- Press Releases
- Newsletters
- Brochures
- Common website www.fab-europe-central.eu

C.5 Organisation

The overall consultation process took several forms depending on the audience. Table 10 presents a summary of the various consultation initiatives that took place and their respective objectives. All consultation initiatives were accomplished by handouts of the presentations as well as the publications and standards mentioned above.

Initiative	Target audience	Location, date	Objectives	Content
Common booth at ATC Global exhibition	ANSP community All stakeholders	Amsterdam, 11 to 13-Mar-08	Provide opportunity to ask questions Show presence	General project overview Status of the project
Stakeholder Forum 1	All stakeholders	Brussels, 16-Feb-07	Inform on the aims of the study, the working method and the key issues facing the WGs	General project overview
Stakeholder Forum 2	All stakeholders	Paris, 11-Dec-07	Inform on the progress of the feasibility study and the way forward Gather views on the intermediate results	Progress of the WGs Status FAB Airspace design Fast-time simulations ATM operational concept Roadmap Future technical Systems Status CBA Status HR Plan Status Regulatory regime
User Expectation Workshop	Customers/users	Langen, 30-Jan-07	Seek views on topics which have an impact on operational issues Understand at an early stage the operational expectations of key users Help determine how best to match users' future operational and business requirements to the underlying ATM service concepts	General project overview

Initiative	Target audience	Location, date	Objectives	Content
Customer Consultation Workshop	Customers/users	Zurich, 27-Feb-08	Inform on the progress of the feasibility study and the way forward Gather views on the intermediate results	Progress of the WGs Results Fast-time simulations FAB airspace design ATM operational concept updated Contingency concept Roadmap Future technical Systems Status CBA Status Safety case
National meetings	Customers/users	Various	Inform on the progress of the feasibility study through regular status reports Communicate operational benefits Prevent the development of rumours	Various information updates, depending on the work and results of the different WGs
Round Table on financial aspects	Customers/users	Frankfurt, 19-May-08	Give opportunity to ask questions concerning CBA and other financial aspects	Financial aspects Methodology of the CBA Charging
Workshop on social dialogue process for FAB implementation	ANSP staff representative organisations and European staff organisations	Brussels, 24-Apr-08	Give ANSP level and European staff organisations platform to express their point of view on how the social dialogue process should be set up for the FABEC implementation phase	Social dialogue process
Meetings with European staff organisations	European staff organisations	Paris, 24-Sep-07 Brussels, 29-Feb-08	Discuss the results of the WG with unions	Progress and results of the WGs

Initiative	Target audience	Location, date	Objectives	Content
Meetings with European staff organisations	European staff organisations	Brussels, 23-May-08	Discuss the results of the WG with unions Give staff organisations platform to express their point of view and raise questions	Progress and results of the WGs

Table 10 Outline of the consultation process

D Airspace design

D.1 Short term airspace design

In Section 3.1 it was mentioned that in particular on the interface areas between States and ANSPs, fragmentation of the airspace is an issue in the present situation. To deliver benefits to the airspace users in the short term, i.e. before the introduction of FAB-wide optimised airspace design, some of the critical areas on these interfaces can be addressed: the so-called 'hotspots'.

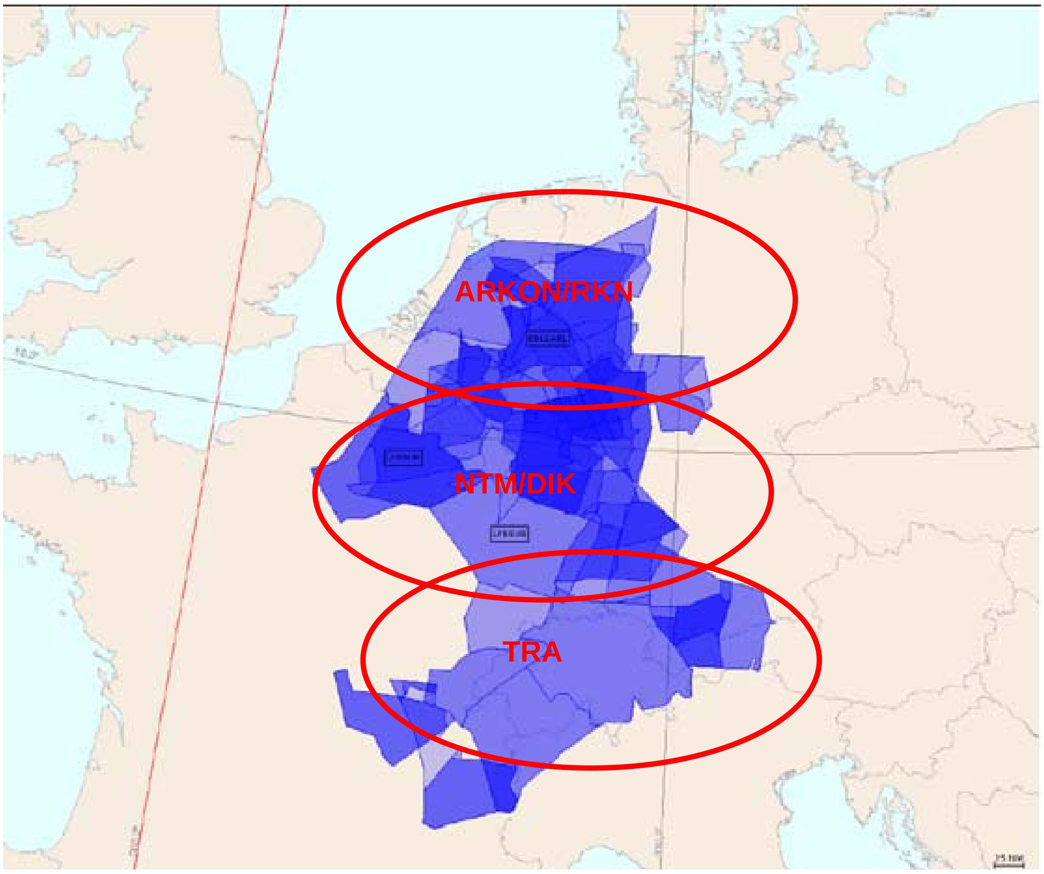

Figure 27 Central core area of the FABEC with identified hotspots

Three 'hotspots' were identified in the FABEC area for consideration within the feasibility study. These three areas contain some of the busiest and most complex airspace in the region as both the north-south and the east-west axis traffic flows cross through this airspace. The areas are located at the interface between multiple ANSPs;

- ARKON/Rekken (RKN) - interface area with LVNL, DFS, MUAC, RNLAF and GAF
- Nattenheim (NTM)/Diekirch (DIK) - interface area with DSNA, Belgocontrol, MUAC, DFS, BAF, DIRCAM and GAF
- Trasadingen (TRA) - interface area with skyguide, DFS, DSNA and SAF

For each of the hotspot areas a new design was developed in the feasibility study. The design of the three individual areas is consistent, meaning that together they constitute a redesign of the whole area indicated in Figure 27.

The design was evaluated using fast-time simulations. Within the analysis the following differentiation of potential conflicts was made:

- Conflicts up to 5NM - critical undershooting of the separation between two aircraft, an air traffic controller has to take action to avoid an impact of these two aircraft.
- Conflicts up to 10NM - typically an air traffic controller gives no instruction but will take care about a potential approximation of these two aircraft.

It is possible that the number of potential conflicts up to 10NM increases in the new design. This is not necessarily an indication that the new structure is worse than the original structure; potential conflicts may have shifted from a critical towards a less critical situation, with related reduction in workload.

D.1.1 ARKON/RKN hotspot

The improved airspace structure was developed on the basis a route network (split at FL305) with segregated departures and arrival link routes (below FL305 to FL245) from/to the main airports. An over flying ATS route network (above FL305), linked with those routes of the NTM hotspot group, was superimposed onto this.

The following tables show the results of fast-time simulations of this hotspot area with respect to the impact on number of conflicts.

	P-conflicts up to 5NM	P-conflicts up to 10NM
Reference scenario	131	87
Future scenario	**94**	**95**

Table 11 Conflict Analysis FL95 - FL305 based on TAAM results

	P-conflicts up to 5NM	P-conflicts up to 10NM
Reference scenario	139	50
Future scenario	**80**	**49**

Table 12 Conflict Analysis FL305 - UNL based on TAAM results

The preliminary TAAM results for the proposed airspace organisation demonstrate a reduction of potential conflicts and therefore associated controller's workload which is a confirmation that global capacity in the ARKON/RKN hotspot area might be increased in a short term FABEC perspective.

D.1.2 NTM/DIK hotspot

The improved airspace structure was developed on the basis a route network (split at FL305) with segregated departures and arrival link routes (below FL305 to FL140) from/to the main airports. An over flying ATS route network (above FL305), linked with those routes of the other hotspot groups, was superimposed onto this.

The large amount of traffic using this airspace region has to be accommodated in between a number of different military areas that are mostly active when civil demand is high.

Results of fast-time simulations are presented in the tables below.

	P-conflicts up to 5NM	P-conflicts up to 10NM
Reference scenario	182	121
Future scenario	**165**	**113**

Table 13 Initial Conflict Analysis FL95 - FL305 based on TAAM results

	P-conflicts up to 5NM	P-conflicts up to 10NM
Reference scenario	159	71
Future scenario	**135**	**77**

Table 14 Initial Conflict Analysis FL305 - UNL based on TAAM results

The overall results of the TAAM simulation are showing a reduction of around 5 to 10% in potential conflicts below FL305. Above this level, a decrease of 10% potential conflicts is observed in the 5NM-scenario, but an increase of 10% is observed in the 10NM-scenario

D.1.3 TRA hotspot

The potential to raise the capacity and/or effectiveness in the TRA area was estimated as lower than in the other two hotspots. This estimation was based on the fact that the area was completely reorganised in the year 2000. This reorganisation was strictly based on the basic planning principles of the European Airspace Planning Manual with a segregation of routes and a sectorisation delineated along main traffic streams disregarding political borders. This airspace organisation is still showing a good operational performance. However, some minor gains have been extracted from the proposed changes.

	P-conflicts up to 5NM	P-conflicts up to 10NM
Reference scenario	287	160
Future scenario	**277**	**149**

Table 15 Initial Conflict Analysis FL125 - UNL based on TAAM results

The overall results of the TAAM simulation are showing modest potential for improvement around the TRA area for the 5NM scenario but a more significant decrease in potential conflicts for the 10NM-scenario of around 5%.

D.1.4 Output of hotspot design

The three hotspot models have been merged into a single scenario, considering the airspace to be one continuum with seamless transitions.

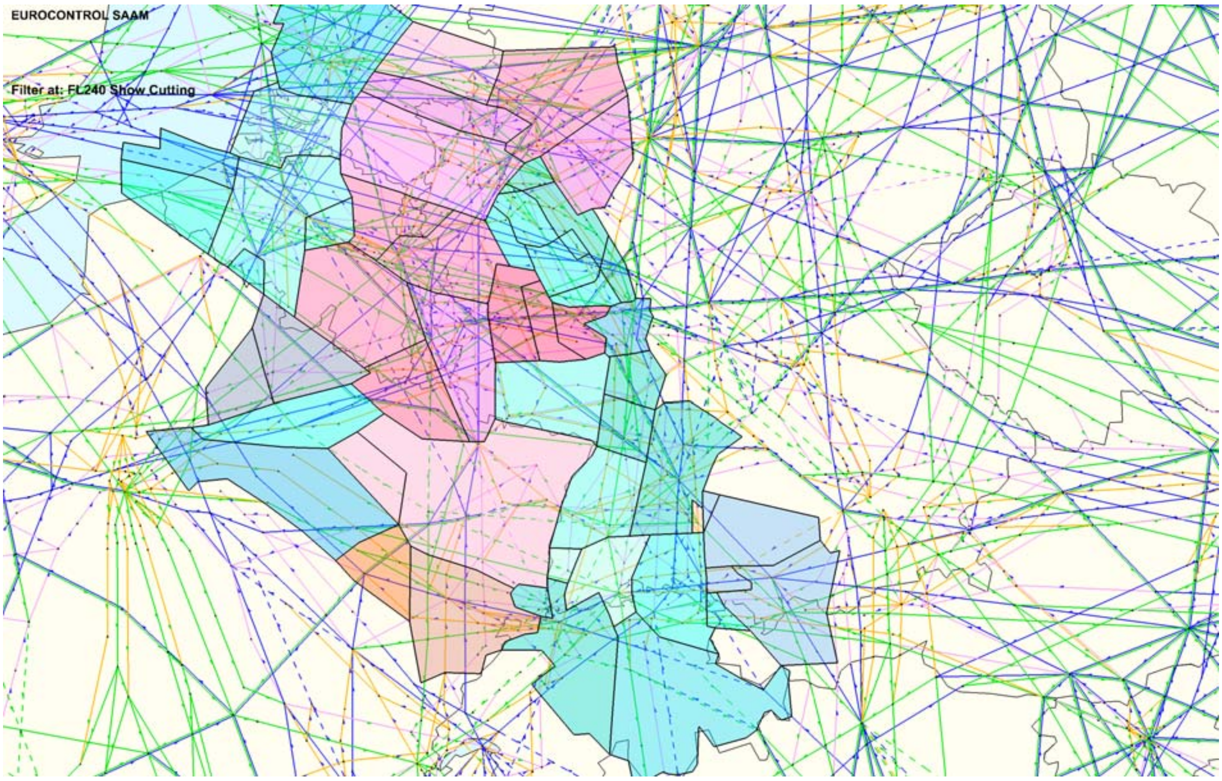

Figure 28 Short term sectorisation at FL240

The results of the hotspot design and related fast-time simulations are promising, however, a number of open issues still exist that will need to be addressed before implementation, e.g. the impact of redesign of hotspot areas on adjacent airspace and location of crossing points in relation to sector borders. Further validation will need to take through, among others, real-time simulations.

D.2 Medium/long term airspace design

D.2.1 Assumptions and general design criteria

For the medium/long term airspace design process a number of important planning criteria were applied, of which the primary ones were:

- The airspace considered was limited to UAC/ACC sectors (without TMAs)
- Airports with more than 100 movements per day were modelled with lateral entry/exit points to TMAs, all others were only modelled with vertical profiles
- Independent routes were spaced by at least 7NM
- Minimum route spacing from military training areas was set to 6NM

D.2.2 The 5 step approach

The task followed a 5 step iterative approach, using the EUROCONTROL SAAM tool for macroscopic analysis:

Step 1: Planning the long term flow structure

Consider and accommodate the major traffic streams as most direct flows and create additional parallel flows if necessary (different flow options are to be considered).

- Develop the future FABEC flow network
- Consider arrival and departure flows to/from major aerodromes

Step 2: Develop military training areas

Develop ‘white spots’ towards an airspace structure to cope with the military requirements. ‘White spots’ are areas of less civil traffic density.

- Identify ‘white spots’ for optimisation of military use airspace
- Consider the development of CDR/advanced FUA

Step 3: Develop corresponding ATM sector family scenarios

Develop ‘sector family scenarios’ according the EUROCONTROL Advanced Airspace Scheme to show the strategic direction for change

- Focus for improvements on areas of high complexity
- Flight profiles considered to be on shortest routes and on unrestricted vertical profiles
- Arriving traffic to be at FL300 when 100NM from destination

Step 4: SAAM analysis of the long term airspace design benefits

The long term FABEC airspace design shall allow for a generic analysis of today’s airspace structure based on actual traffic figures and/or forecasted traffic figures.

Step 5: Develop ‘tailored route’ scenario

Develop a ‘tailored route’ scenario, as defined in the operational concept, according the following general criteria:

- Identify area(s), time and level band (s) for ‘tailored route’ applications
- Analyse the link of the ‘tailored route airspace’ to the ‘fixed route airspace’

D.2.3 Development of the target airspace design

Development of ‘FABEC flow network’ (Step 1)

The results of the short term airspace design served as a basis for the planning of the long term flow network. In the study, the following main planning methodology was applied for the ‘FABEC flow network’:

- The SAAM study was limited to the airspace at and above FL285 and consists of a 24 hour traffic projection
- Direct trajectories were considered for analysis between existing FABEC entry and exit points

- For evolving traffic the direct trajectories were considered upon passing FL285
- TMAs and the route network below FL285 remained unchanged
- Scattered direct trajectories were grouped into major direct flows
- At this stage military requirements were not considered

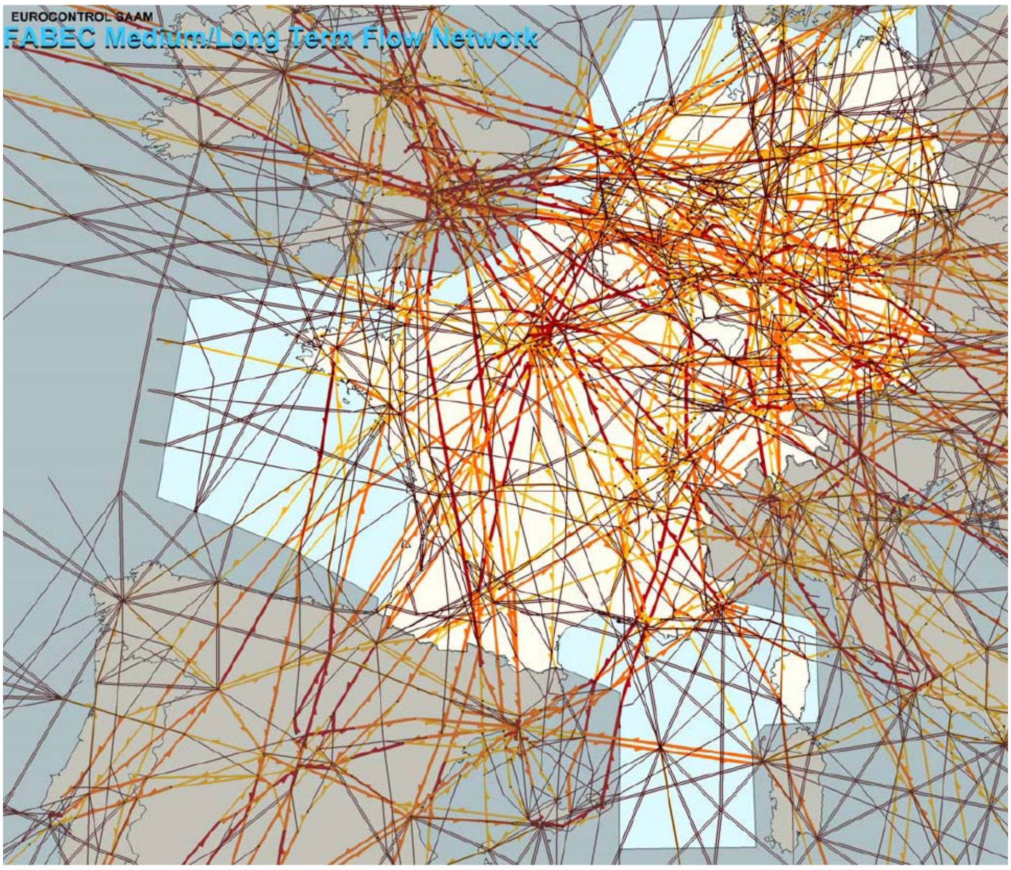

Figure 29 Optimisation of (major) flow orientation

The resulting flow network is presented in Figure 29.

Development of military training areas (Step 2)

As an outcome of step 1 and based on the analysis of traffic load and traffic density plots, a number of 'white spots' were identified in the network of civil air traffic flows. These white spots were used as potential locations for military training areas. This approach was analysed by military partners; based on this analysis the following common statement was made by these partners:

> "*The proposal to identify 'white' spots does not fulfil the future military requirements. But based on a list of assumptions and the possibility to create 'grey' spots in denser civil areas where civil traffic will be rerouted, the possibility exists to fulfil all future military requirements.*"

The impact of this issue will need to be addressed further in the next stages of FAB development. A balance between civil and military requirements needs to be established.

For the feasibility study, a more detailed analysis of the identified white spot airspace was developed in an attempt to accommodate the military requirements. This development was limited to sample white spots in the FABEC core area, which is considered the most critical area.

Analysis of Sample Military Training Areas in the FABEC Core Area

The sample areas 'Dunes', 'Bouillon', Champagne' and 'Sarre', indicated in Figure 30, were further developed and subdivided in an attempt to reconcile contradicting civil and military demands.

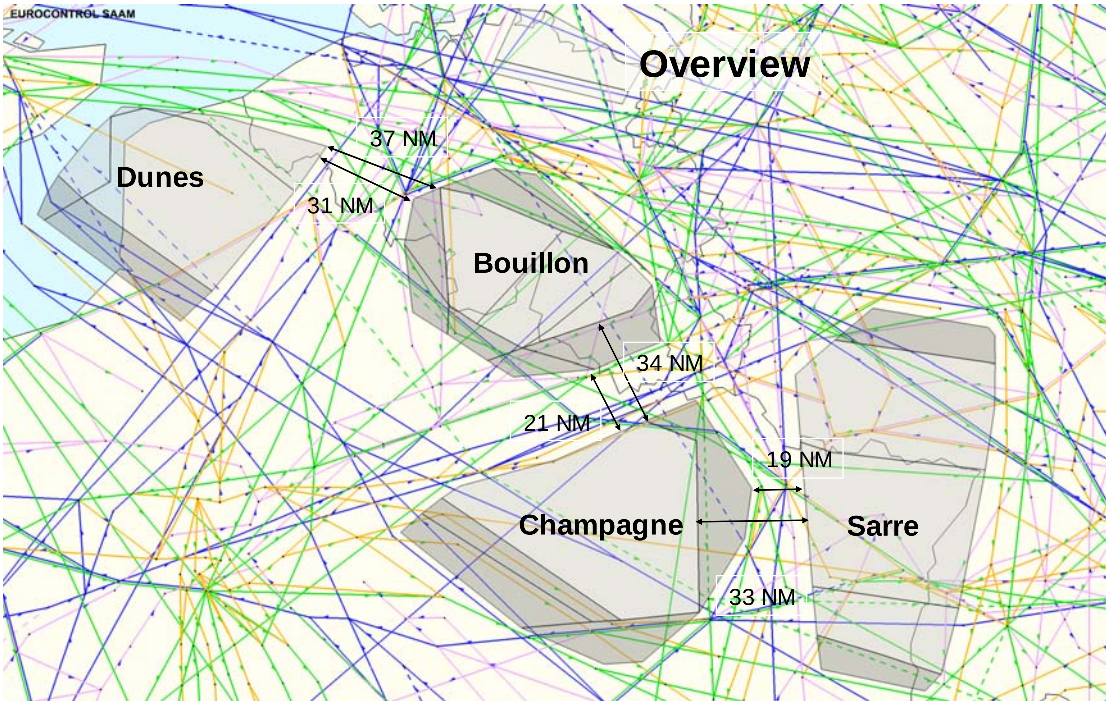

Figure 30 Subdivision of sample military training areas in the FABEC core area

(Note: Depicted distances are for general overview and do not represent finally agreed values)

The military partners made the following summary of their analysis of the redesign of the military training areas:

- The future requirements for both civil and military are not compatible to 100%, some missions cannot be flown in this future scenario.
- The mission effectiveness for each type of mission can only be met with adequate dimension of training area.
- In this exercise only lateral limits have been investigated in regard to the mission profiles. Vertical/time limits have not been taken into account. However this main criteria will be fundamental to define the type of mission for each area.
- To share subdivisions in an area with multiple users, it is necessary to define priority rules.
- Environmental issues have not been considered.

- For the military evaluation no buffers inside the military areas have been considered.

The following statements from the civil parties were provided with the analysis:

- The flow concept will have to be further developed to a detailed route network and the design should be taken as a direction for further development .
- Between the grey zones of the areas DUNES and BOUILLON, BOUILLON and CHAMPAGNE and between CHAMPAGNE and SARRE, sufficient airspace should be made available to accommodate major civil traffic flows.
- During periods of peak demand from the main FABEC airports it will be necessary to accommodate the future demand on available Conditional Routes (CDRs). In addition major flows from surrounding main airports will also have a significant effect and this will require further evaluation.
- The medium/long term is a qualitative exercise and therefore a fine-tuning will have to be done before any implementation.

Conclusions on military training areas

The military need for larger airspace at shorter time periods and the forecasted high increase of civil traffic flows are to be accommodated within a defragmented, but limited, airspace resource.

From the detailed analysis focussed on the European core area it becomes clear that the contradicting demands from civil and military airspace users can not be completely fulfilled with the available airspace design tools in the FABEC core area.

A clear political decision (FUA level 1) is needed, regarding to which extent which demand for the use of the available airspace is to be fulfilled. The management of the airspace (FUA level 2/3) is to be organised based on this decision along agreed priority rules. A draft set of priority rules was developed in the feasibility study.

A detailed further analysis of potentially contradicting civil and military airspace demand in other areas of the FABEC is still to be done.

<u>Development of corresponding sector family scenarios (Step 3)</u>

'Sector families' were developed, by analysing the traffic density and conflict density within different level bands in the entire FABEC area. Three different 'sector family scenarios' were developed to show the strategic direction for the long term airspace design, targeted to overcome the fragmentation of the FABEC airspace.

Resulting from operational experience, between 2000 and 3000 flights per day was considered to be a manageable traffic load for one sector family. However, this depends on the individual sector layout that needs to be designed for each family in future development steps.

The development of the three scenarios does not set a concrete baseline for next phases of FAB development. Other sector families may be developed using different development principles such as other division levels or prioritisation of other flows (e.g. north-south).

	Scenario 1: 'Colour' sector families	Scenario 2: 'Writers' sector families	Scenario 3: 'Car' sector families
Main development principles	Homogeneous traffic distribution within sector families Division for analysis at FL315 to cope best with evolving/over flying traffic streams Analysis of traffic density plots and conflict density plots in the corresponding level bands	Homogeneous traffic distribution within sector families Division for analysis at FL315 to cope best with evolving/over flying traffic streams Analysis of traffic density plots and conflict density plots in the corresponding level bands Consideration of evolving flows around major aerodromes; all traffic below FL115 considered to be terminal traffic outside sector families 'Central sector family (SIMENON)' dealing with major European evolving traffic streams was designed as column from FL115 to FL355	Homogeneous traffic distribution within sector families Division for analysis at FL285 and FL355 (3 layer Model) to cope best with RVSM airspace and evolving/over flying traffic streams Analysis of traffic density plots and conflict density plots in the corresponding level bands Consideration of evolving flows around major aerodromes; all traffic below FL115 considered to be terminal traffic outside sector families Sector families organised to best accommodate east-west/west-east flows
Description	The 'Colour Low sector families' extend from GND to FL315 except 'Blue Low sector family' extending from GND to FL195. In the medium level band only one 'Colour sector family' is foreseen. This 'Blue Medium sector family' extends from FL195 to FL315. The 'Colour High Sector Families' extend from FL315 to FL660.	The 'Writers Low sector families' extend from FL115 to FL315 except 'SIMENON sector family' extending from FL115 to FL355. The 'Writers High sector families' in general extend from FL315 to FL660. The eastern part of 'NOTHOMB sector family' located overhead 'SIMENON' extends from FL355 to FL660 the western part of 'NOTHOMB' from FL315 to FL660.	The 'Car Low sector families' extend from FL115 to FL285. The 'Cars High sector families' extend from FL285 to FL355. The 'Cars Upper High sector families' extend from FL355 to FL660.

	Scenario 1: 'Colour' sector families	Scenario 2: 'Writers' sector families	Scenario 3: 'Car' sector families
Conclusions of analysis	Relatively balanced family loads Operationally sound number of interactions Location of sector family boundaries in areas of lower interaction Vertical division of the airspace according to different traffic characteristics (evolving/transit)	Relatively balanced family loads Operationally sound number of interactions Location of sector family boundaries in areas of lower interaction Beneficial organisation of sector families around evolving streams, especially in the 'Low sector families' Integration of evolving traffic streams into major transit flows in the 'High sector families' Vertical division of the airspace according to different traffic characteristics (evolving/transit)	Balanced family loads Operationally sound number of interactions Location of sector family boundaries in areas of lower interaction Design of sector families along major northwest-southeast traffic streams Vertical division of the airspace according to different traffic characteristics (evolving/transit).

Table 16 Details of sector family scenarios

Colour scenario

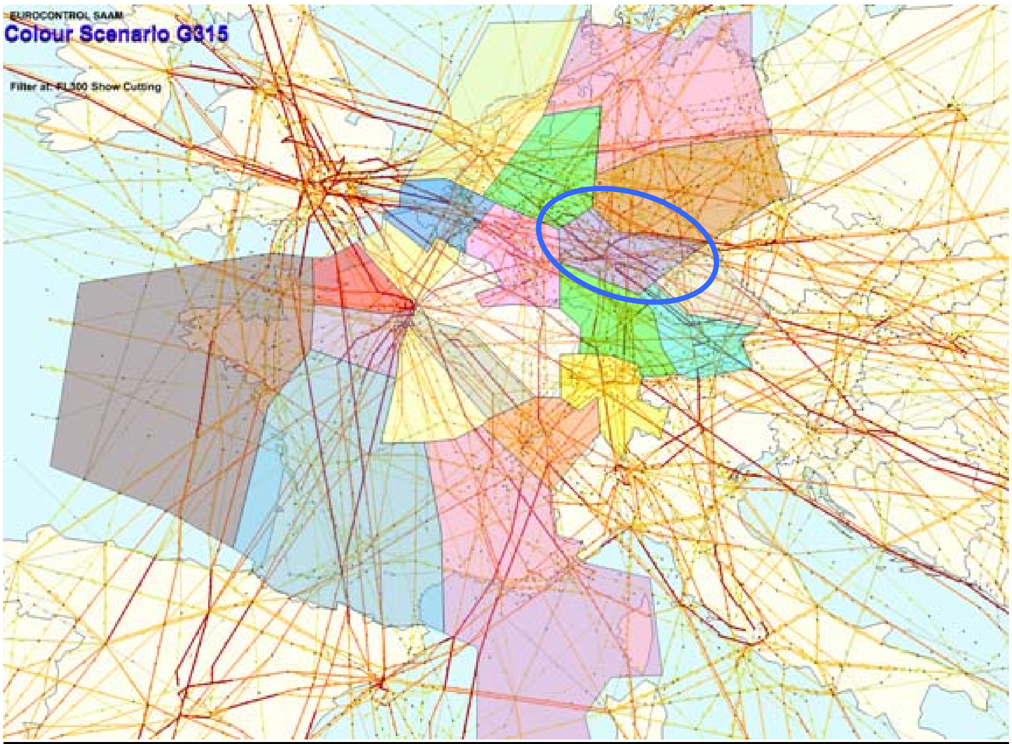

Figure 31 Colour scenario at FL300: Low sector families

Note: 'Blue Medium sector family' indicated, see Table 16 for description.

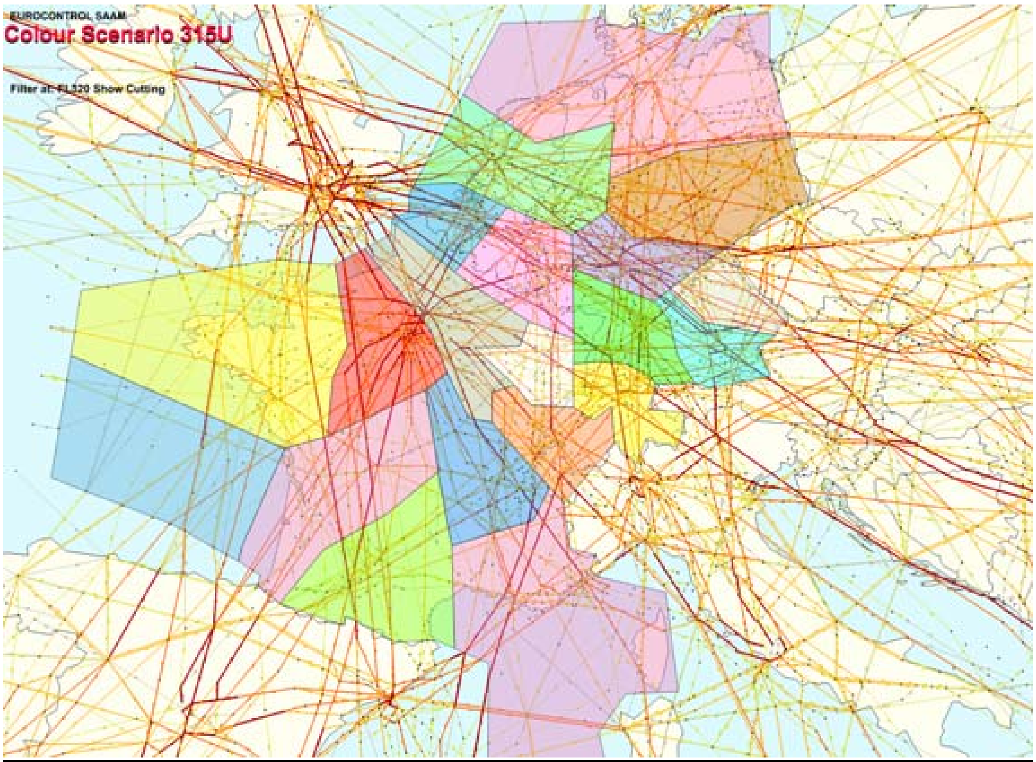

Figure 32 Colour scenario at FL320: High sector families

Writers scenario

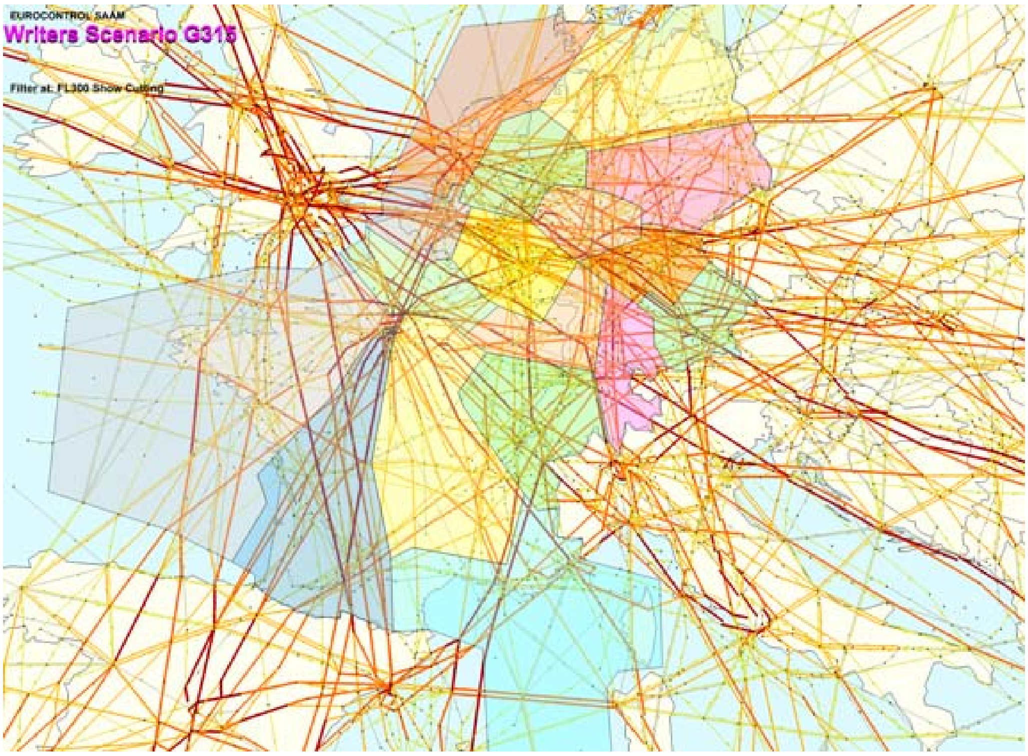

Figure 33 Writers scenario at FL300: Low sector families

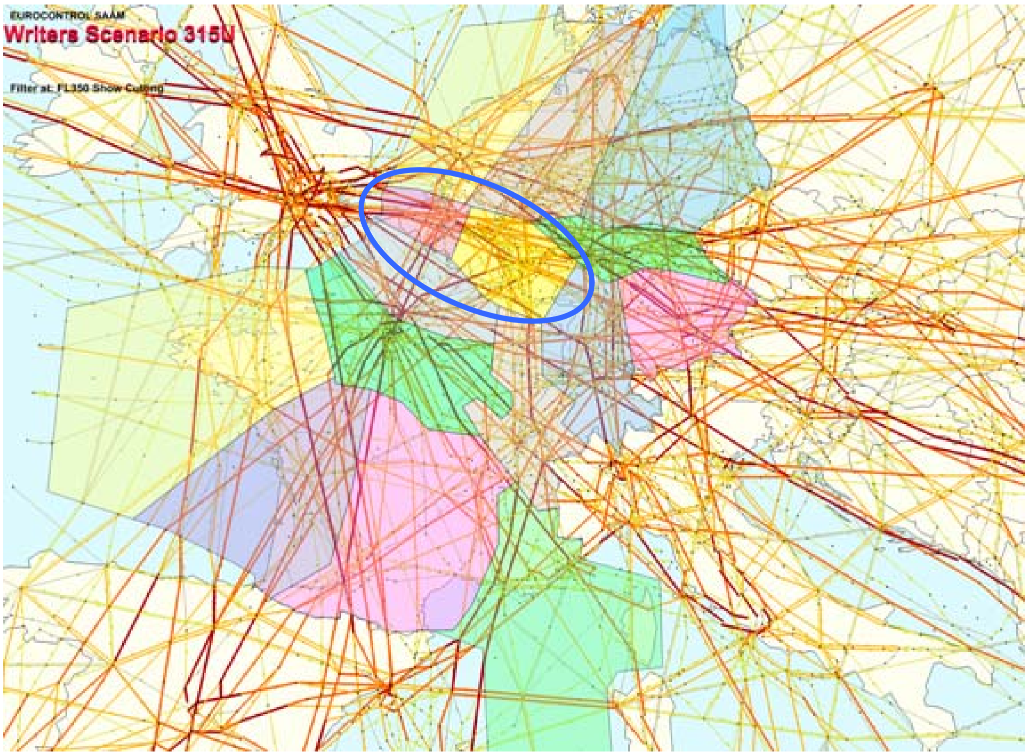

Figure 34 Writers scenario at FL355: High sector families

Note: ‘SIMENON sector family’ (east) and ‘NOTHOMB sector family’ (west) indicated, see Table 16 for description.

<u>Car scenario</u>

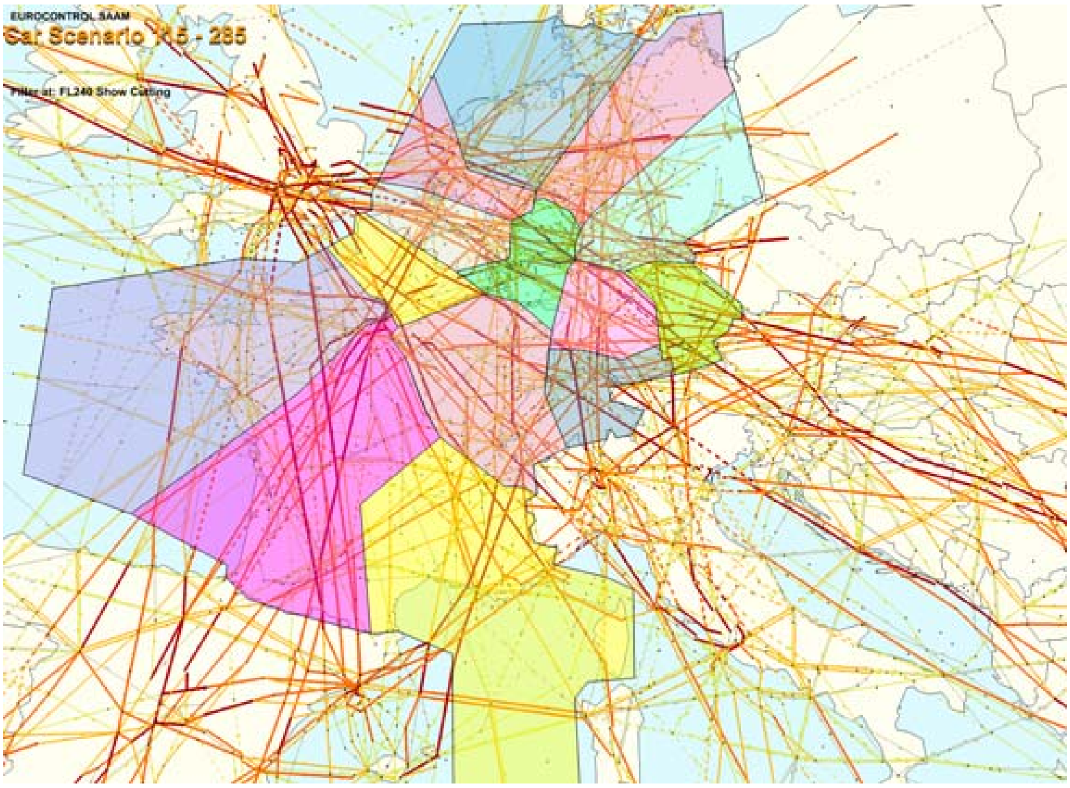

Figure 35 Car scenario at FL240: Low sector families

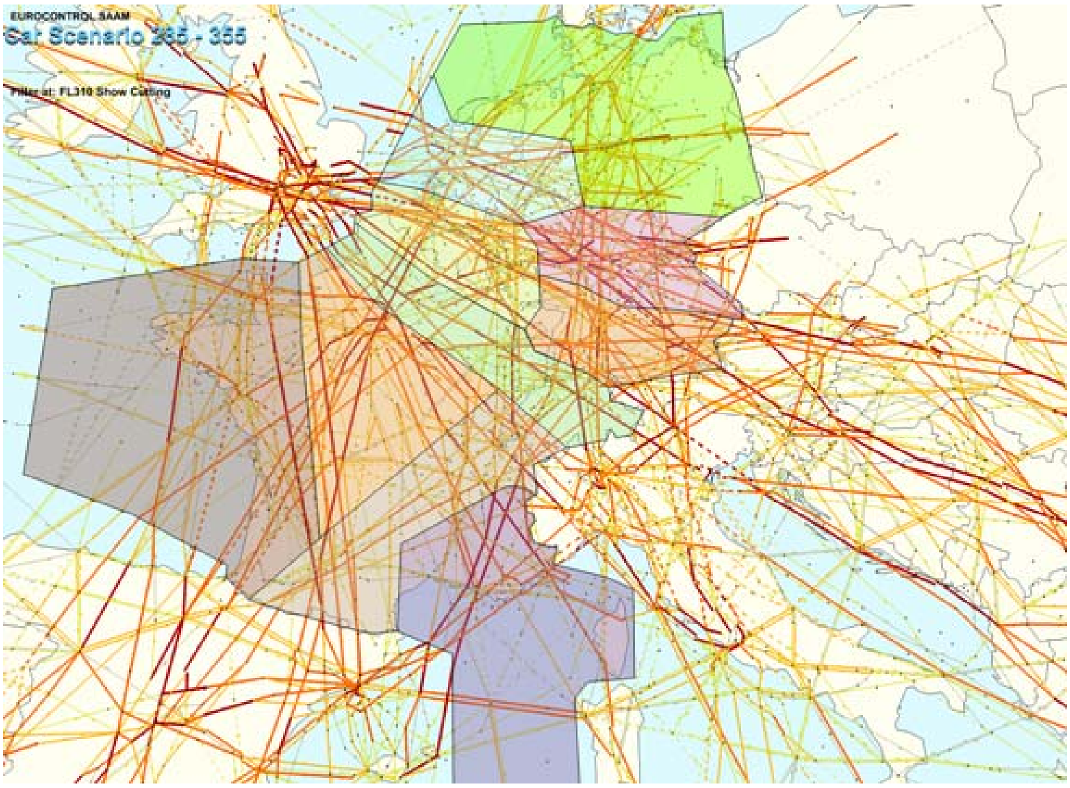

Figure 36 Car scenario at FL310: High sector families

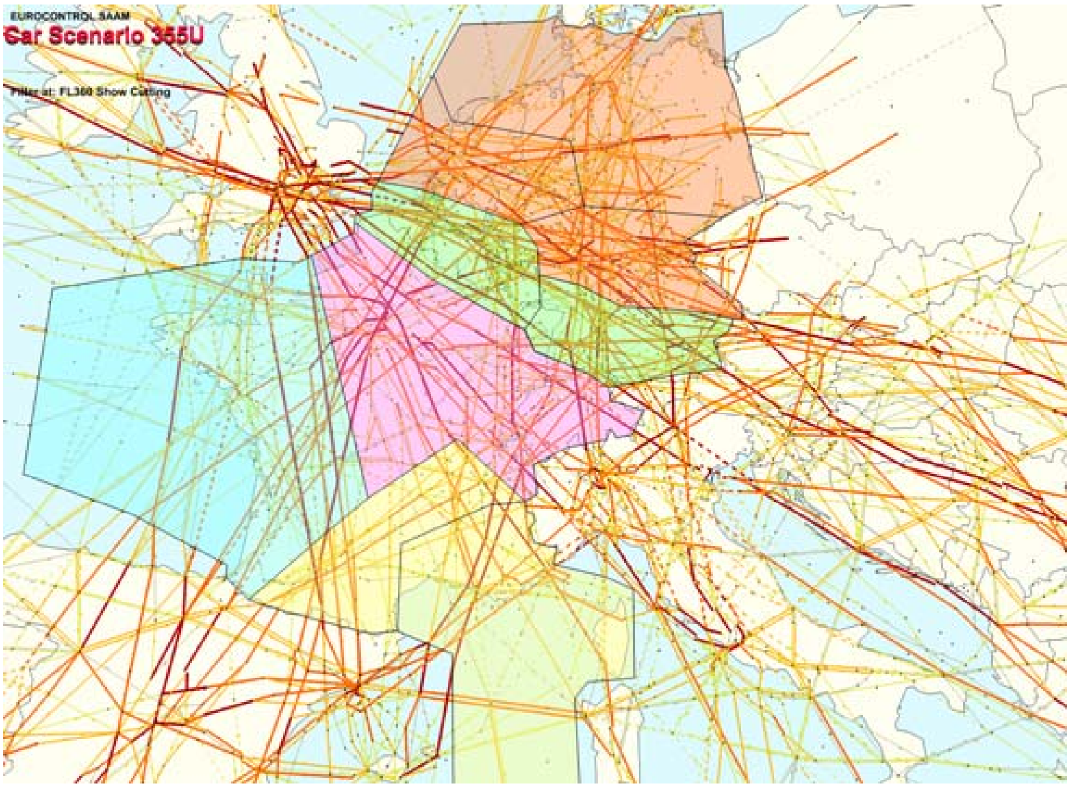

Figure 37 Car scenario at FL360: Upper High sector families

SAAM analysis of target airspace design (Step 4)

The route length analysis was done by comparing the distance flown on a given route/flow network with the great circle distance (route extension network versus shortest route length possible).

The difference between the different networks in terms of route length was calculated by comparing the respective total extension figures (%). As the flow network elaborated in step 1 was developed for the airspace above FL285, the results refer to this volume of airspace.

Depending on the activation, or not, of military training areas within the analysis the route extension using the FABEC flow network as designed in the SAAM tool showed an approximate 1.5-2% reduction from the baseline current route network. As this figure compares the current route network with an approximation of a future flow network the results need to be taken to read only that possible benefits exist, but that specific route design aligned to a future flow network and military activation times may reduce these benefits.

Development of ‘tailored route’ scenarios (Step 5)

Description of tailored route operations in tailored route airspace can be seen as a development of the current practice of direct routing clearances issued by ATC. In this airspace aircraft will be able to flight plan their own user-preferred trajectories (subject to any overriding airspace restrictions) within a known environment (their identity, position and intentions are known) and with links to the structured routes at both ends. ATM intervention will be more frequent at pre-tactical level than currently and will utilise the principles of collaborative decision making to determine and agree the best course of action for flights.

The preferred trajectory may change from day-to-day because of changing airspace restrictions, the differing strategic options of the flight operator and by the vagaries of the weather and other traffic. The development of automated support systems in the air and on the ground, coupled to new procedures and working arrangements in ATM, will permit the use of tailored route operations in managed airspace and so provide significant benefits in flight economy and flexibility for users. Military aviation has a vital role to play in the security of each State. Tailored route airspace will support the level of military effectiveness required by each State.

Basic assumptions

For the development of the tailored route scenario the following basic assumptions were made:

- Tailored route system (TRS) is to be handled within one tailored route family (6-10 sectors)
- Availability of a sophisticated ATM system is anticipated
- Automatic flight plan processing within (different) FDPS
- Silent coordination capabilities
- MTCD etc.
- Transition between TRS and fixed route system is to be based on common procedures
- Accommodation of military activities must be assured
- Availability of an airspace management tool etc.

Analysis of tailored route scenarios

The overall traffic distribution and the corresponding conflict density in different level bands within FABEC were analysed for a 24 hour time period and in time slides between 21hrs-05hrs and 22hrs-04hrs.

The analysis was based on the conflict density with 12NM buffer infringements, the direct traffic trajectories combined with the conflict density 5NM buffer infringements and the direct traffic trajectories combined with the conflict density 12NM buffer infringements.

Based on the detailed analysis the following statements on the general feasibility of the tailored route concept for the FABEC airspace can be made:

- Between 22hrs and 4hrs (UTC) tailored route airspace considered feasible for the entire FAB from FL245+ (1981 flights, 486 conflicts, one tailored route family)
- Between 4hrs and 22hrs (UTC) tailored route airspace considered feasible for the entire FAB from FL385+ (1430 flights, 349 conflicts, one tailored route family)
- Further study on second tailored route scenario between 4hrs and 22hrs from FL375+ is recommended (2856 flights, 1091 conflicts, one tailored route family)

SAAM analysis of additional benefits of tailored route scenario(s)

In general the route length analysis was conducted by comparing the distance flown on a given route/flow network with the great circle distance (route extension network versus shortest route length possible).

Within tailored route airspace all flights were considered on direct tracks.

For the calculation of tailored route benefits a more detailed analysis of the traffic figures was performed. Consequently only flights transiting through the tailored route airspace with a minimum of 100NM flight distance and excluding all flights staying below the indicated division flight level of the tailored route airspace were considered.

The analysis shows that some potential reduction of route extension compared to the current network can be anticipated.

D.2.4 Medium/long term airspace development vision

The FABEC detailed feasibility study assessed, on a macroscopic level, the design of the whole FABEC airspace in the medium/long term. This airspace design work was aimed to overcome the fragmentation of the FABEC airspace and to create an enabler for the implementation of FABEC operational concept (tailored route concept, dynamic sectorisation, enhanced FUA). The design work was done in an iterative and systematic 5 step approach:

- Design of major FABEC flows

  Although the current network is already optimised within the boundaries of each FABEC Member State, the study identified room for cross-border improvements considering the overall view of the FABEC operational needs. Through additional coordination with neighbouring FABs further improvements may be derived.

  The study shows the potential for saving miles and fuel burn within the redesigned FABEC flow network and consequently leads to a reduction of the CO_2 emissions.

- Design of military training areas

  Within the FABEC core area the design of the military training areas took into account the redesign of the FABEC flow structure. The design of the training areas focussed on cross-border options to accommodate the military requirements for enlarged training airspace in this area. The subdivision of the military training areas was optimised to make best use of the limited airspace for civil and military demand within advanced FUA applications. However, even these enlarged military training areas could not fulfil all future military requirements.

- Design of sector families

  The developed sector family scenarios show the strategic direction for the medium/long term airspace design, targeted to overcome the fragmentation of the FABEC airspace design. Other sector families can be developed by using different development principles such as other division levels or prioritisation of other (e.g. north-south) flows.

- Tailored route scenarios

  The analysis of the medium/long term airspace design in respect to accommodating the implementation of the tailored route concept led to the following results:

  The application of the tailored route concept was considered feasible above FL385 during the whole day. Based on additional detailed studies another option could be the application of the concept above FL375. During night time between 22hrs and 4hrs UTC the application of the concept seems to be feasible above FL245. In any case a detailed validation of the tailored route concept is required.

- Overall SAAM analysis

  The macroscopic route length analysis was performed to give a general illustration of the potential benefits, which can be derived from the medium/long term airspace design.

From the above macroscopic analysis of the medium/long term airspace design the following can be concluded:

During intense airspace design improvement activities in the heart of the FABEC area (Europe's core area) throughout the last 20 years on expert level, no satisfactory solution could be developed to meet the needs of all airspace users at all times. In this particular area of the FABEC the available airspace does not fulfil the growing demands of civil and military airspace users at the same time because 'airspace' is not an infinite resource. The combination of enlarged military training areas in the congested airspace of the core area and the increasing amount of civil traffic produces an incompatibility between military and civil requirements. Within the frame of the airspace design work no solution satisfying both demands could be found on expert level.

A clear political decision (FUA level 1) is needed, to what extent which demand in respect to the use of the available airspace is to be fulfilled. The management of the airspace (FUA Level 2/3) is to be organised based on this decision along agreed priority rules.

E Common roadmap of technical systems

One objective of the feasibility study was to produce a common roadmap of technical systems which implements the future operational concept in a timely fashion, reduces [sub-]system types, meets performance targets and establishes an infrastructure on which can be established common services so as to minimise operating costs.

The vision for cooperation was as of 2008, a commitment by the ANSPs to carry out joint planning and, by 2020, to have achieved common systems for the major system areas, taking advantage of early opportunities to achieve system commonality and putting a focus on no more than 2 families of [sub-]systems.

The common roadmap on technical systems, covering the major medium to long term developments, consisted of 21 cooperation themes each of which was developed into a ‘roadmap sheet’ setting out the details for the proposed cooperation, assumptions and the approach to be used.

The cooperation themes are presented in Table 17. The related roadmap sheets are then presented in Table 18. The final common roadmap on technical systems is presented in Figure 39 (with the key to the colour-coding of the figure presented in Figure 38).

System	Roadmap step
ATFCM/ASM	Produce a common technical strategy to support the realisation of the ATFM/ASM concept taking account of pan-European (CFMU) developments and the regional/local needs of the FABEC partners. Produce unified data exchange formats and common tool set definitions which can support harmonised and safe coordination procedures between ATC, civil and military airspace users. A first option will be to look at using existing tools (e.g. CFMU tools).
ATS	Maintenance of FDP in two streams expected to be related to iTEC and COFLIGHT. Early implementation/introduction of common streams starting from 2015. Full cooperation is possible if an early decision is made by some ANSPs as to which stream to join.
	Evolution of conflict management tools following the FDP roadmap with a key step in common functionality in 2015.
	Harmonisation of AMAN/DMAN information sharing in line with introduction of FDP IOP function. First movers will achieve this by 2015/2017. This step to be followed by joint development and implementation of arrival/departure management tools.
	Early activities to establish a common basis for a FAB CWP that can support HMI applications and which can be tailored to controller requirements.
	Operational support of ARTAS, and studies on ARTAS, networks and data distribution leading potentially to a reduction of the number of ARTAS units providing track data services.
	Centralise as much as feasible of the ARTAS track data service provision. Establish a minimum number of common SDPS technical [sub-]systems (primary and fallback) in FABEC and agree on common maintenance support and management of evolutionary changes. Obtain an effect of scale.
	Common requirements, standardisation and information sharing for weather information, aircraft performance data, performance and maintenance data, etc.
Communication	Early planning activities aimed at rationalisation leading to common procurement and maintenance on radio systems, VCS and ground communications network infrastructure systems with benefits from as early as 2013. Planning activities leading to establishment of a common air ground data link service provider.
Navigation	Harmonised navigation network from 2012 onwards involving common procurement and maintenance of ILS and DME equipment.
Surveillance	Joint coverage planning from 2008 onwards leading to optimisation of the surveillance infrastructure, common procurement and maintenance (including common planning including the exchange of maintenance data) of surveillance sensors and establishment of a surveillance data sharing infrastructure including the introduction of new surveillance technologies.
Control and monitoring	Joint planning activities leading to centralisation of monitoring and control of the CNS infrastructure.
Technical fallback	A series of cooperation measures leading to the sharing of technical fallback services.

Table 17 Improvement steps for the common technical roadmap

System type	Roadmap improvement element
ATFCM/ASM systems	RS01: Common ATFCM/ASM System
ATS systems	RS02: Common Flight Data Processing System
	RS03: FDP Interoperability
	RS04: Common CWP
	RS05: Common Conflict Management Tools
	RS06: Common Arrival and Departure Management Tools
	RS07: Common Safety Nets
	RS08: Common Maintenance & Operational Support of ARTAS
	RS09: Centralisation of ARTAS Track Data Services
	RS10: Common Planning on Flight Identification
	RS11: Common Data Services
Communication systems	RS12: Common Procurement & Maintenance of Radio Equipment
	RS13: Common Procurement & Maintenance of VCS
	RS14: Common Procurement & Maintenance of Ground Communications network infrastructure
	RS15: Common AGDL Communication Infrastructure and/or Service Provision
Navigation systems	RS16: Common Procurement & Maintenance of ILS & DME
Surveillance systems	RS17: Optimisation of Surveillance Infrastructure
	RS18: Common Procurement & Maintenance of SUR Sensors
	RS19: Surveillance Data Sharing Infrastructure
Control and monitoring systems	RS20: Centralisation of Monitoring & Control of CNS infrastructure
Technical Fallback	RS21: Sharing of Technical Fallback services

Table 18 Overview of technical cooperation themes

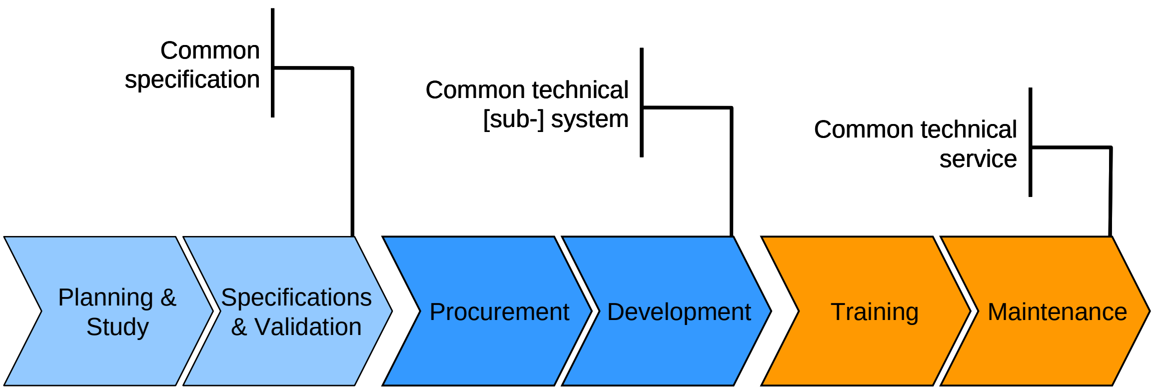

Figure 38 Colour-coding of life cycle indication in roadmap

Figure 39 Common roadmap on technical systems

F Safety study results

In support of the FAB feasibility activities a safety case covering the proposed FAB's operational and technical aspects was planned and conducted. In the feasibility study a full safety case as it is commonly understood is neither necessary nor possible to be achieved, considering the early stage of development. Therefore only an indication is provided stating the likelihood that the FAB will meet the specified overall safety objective. Within the feasibility study of FABEC, safety case development activities thus result in the provision of a 'safety feasibility indication'. For the eventual design and implementation of the FAB, the development of a FABEC safety case is proposed.

The safety feasibility indication was developed through two iterative activities. The first activity was based on the main operational changes. The second activity was based on the operational development as described in the common operational concept, which already took into account some of the results of the safety activities relating to the MOCs.

The safety feasibility indication provided an assessment of the likelihood that the FAB will meet the specified overall safety objective, based on:

- The common operational concept
- An assumed air traffic growth in the FABEC airspace
- The safety assessment methodology and safety criteria developed within the study
- The inputs of operational and technical safety experts in workshops

F.1 Safety assessment methodology

The methodology used for the safety feasibility study is based on EUROCONTROL's Safety Assessment Methodology (SAM) for Air Navigation Services. SAM is subdivided into three main processes, Functional Hazard Analysis (FHA), Preliminary System Safety Assessment (PSSA) and System Safety Assessment (SSA).

Considering the early stage of development of the FAB, the SSA does not apply here. Due to the high level of abstraction in the operational documents on which the safety case development activities are based, the remaining processes FHA and PSSA have been undertaken in a qualitative and high level way. Two iterative parts of a high level FHA and PSSA have been performed.

The first iteration of the FHA and PSSA was based on the 15 Main Operational Changes. It was performed in two workshops that involved operational, technical and safety experts from across the FAB. At this stage the main hazards associated with the MOCs were identified and potential remedies for the identified hazards discussed. The safety impact of the hazards (defined as the combination of the severity of the potential effects of the hazards, and the conditional probability that these effects take place, given the occurrence of the hazard) were established.

The second iteration was based on the FABEC common operational concept and again featured two further workshops with operational and technical staff. In this second iteration, the workshops focussed on the 'risk' of the identified hazards. 'Risk' is the combination of the severity of the potential effects of the hazards, and of the frequency of these effects. Direct expert judgement of the risks in the FABEC operation was used. The experts judged the risk in terms of absolute incident and accident risks.

F.2 Safety criteria

The overall safety objective for the FABEC concept follows from the question "*Will the FAB be safer than today's operation?*". From this, the overall safety objective has been defined in [Ref. 3] as follows: "*The future operations, with the predicted increased amount of movements in the FABEC airspace, will not result in an increase of the number of accidents and risk bearing incidents per year that are in some way related to ATM. Therefore this will mean that the safety level per movement has been increased.*"

This overall safety objective is further clarified by the following definition.

'Related in some way to ATM' means:

- Events in controlled airspace due to:
    - loss of separation between 2 or more aircraft, or
    - loss of separation between an aircraft and obstacles, vehicles or terrain
    - wake vortex encounters

  regardless of the causal factors, or
- Events due to (failure of) a service provided by an ANSP (e.g. weather info, traffic info)

The methodology proposed is based on experts' best guesses. Therefore, the overall safety objective has not been detailed further into quantitative safety criteria.

F.3 Results

Most of the summarised hazards that were identified were assessed not to constrain further safe development of the FAB. A number of safety issues were identified that could prevent a FAB based on the operational concept from being further developed in accordance with the overall safety objective. For most of these safety issues, sufficient feasible and effective mitigating measures have been identified. For five issues however, sufficient remedies have not yet been identified:

- Communication and surveillance problems with UAVs
- Autonomous aircraft operations
- Communication problems regarding dynamic sectorisation
- Interception of civil aircraft with a communication failure by military jets
- Emergency descents

A safe FAB can thus only be developed based on the FABEC operational concept if these five issues are addressed. The current remedies are not expected to reduce the risk sufficiently. Moreover, the operational concept has not covered this subject.

For three of these issues, it is argued that a more detailed safety analysis is necessary before it can be indicated whether the FAB can be made safe. These issues are communication and surveillance problems with UAVs, autonomous aircraft operations, and communication problems regarding dynamic sectorisation. Each of these three issues considers complex operations that are not easily analysed based on expert opinion only. Additionally, these operations have not yet been researched and developed in detail, and the feasibility depends on the further R&D.

The other two issues both consider aspects that have not been considered in the operational concept. These issues are interception of civil aircraft that have a communication failure by military jets, and emergency descents. No remedies have been identified that reduce the risk related to these issues sufficiently to indicate whether the FAB can be made safe.

It is noted that some of the identified issues are related to developments that may occur irrespectively of the FAB being introduced or not (traffic growth and introduction of UAVs), but which nevertheless need to be safely accommodated.

In case these five issues can be solved and all safety requirements are fulfilled, then there is justified, expert-based confidence that a FAB based on the operational concept can be made sufficiently safe to comply with the overall safety objective. Evidence that these issues can or cannot be solved could not be identified. The safety requirements include the identified potential remedies and the assumptions made about the operational concept.

This is a safety feasibility indication only; a full safety case shall be built in the further development of the FAB. It is recommended that difficulties or weaker aspects that were encountered in the applied approach, such as the coverage of combinations of hazards, are considered when optimising the approach to be applied for developing the full safety case.

F.4 Validation

The results of the safety feasibility indication have been proofed by specialists independent of the safety assessment. The conclusion was that:

- The safety activities output are verified and valid
- The defined criteria/methodology to be followed for such a FABEC safety feasibility study was followed.

As a result the evaluation tasks confirm the validity of the obtained results.

Three recommendations were made for future developments:

- Explicitly consider various scenarios in order to identify hazards and their effects
- The safety remedies should be considered at a broader level (with other FABEC Working Groups) for the next phase of the FABEC project
- The conclusion of the evaluation report should be fed back to those who were involved in the original work

F.5 Conclusions

The final safety feasibility study of the FABEC project has been performed. Considering the early stage of development, a full safety case cannot yet be delivered; instead, the result is a safety feasibility indication, giving an indication of the likelihood of meeting the overall safety objective once the FAB would be designed.

The hazards related to the FABEC common operational concept have been structured into summarised hazards. Most of these summarised hazards were assessed not to prevent a further safe development of the FAB. A number of safety issues have been identified that can prevent that a FAB based on the operational concept can be further developed complying with the adopted safety criteria. For some of these issues remedies are required, and for some others of these issues remedies are recommended. For most of these issues, sufficient feasible and effective potential remedies have been identified. Five issues have been identified which may cause that a FAB based on the operational concept cannot be further developed to be safe.

In case these five issues can be solved in further research and development, and all safety requirements are fulfilled, then there is justified, expert-based confidence that a FAB based on the operational concept can be made sufficiently safe to comply with the overall safety objective. Evidence that these issues can or cannot be solved could not be identified. The safety requirements include the identified potential remedies and a number of assumptions made about the operational concept.

The results of this final safety feasibility study shall be taken into account in the further development of the FAB, after the feasibility study. Then, also the full safety case shall be built. It is recommended that difficulties or weaker aspects that were encountered in the applied approach, such as the coverage of combinations of hazards, are considered when optimising the approach to be applied for developing the full safety case.

G CBA results

A cost-benefit analysis is a method of examining the totality of costs and benefits to a wide variety of parties who will be affected by a project. Such an analysis is sound practice for any major investment in the ATM industry. In addition, the SES legislation requires that FAB proposals by Member States should be justified by a cost-benefit analysis.

G.1 Content of the analysis

The cooperation proposed in the FABEC detailed feasibility study involves a number of initiatives between the participating ANSPs. Such initiatives will bring benefits, which can accrue directly to airspace users, in terms of improved quality of service and reduced costs of using the airspace, or indirectly, through reductions in ANSPs' costs, which will in the fullness of time be passed through to airspace users as reduced user charges.

The benefits will be to some extent counterbalanced by additional operating costs. More significantly, each initiative is likely to bring with it certain transition costs – the costs to the ANSPs of attaining the required level of cooperation that will bring net benefits. These transition costs could comprise:

- Set-up costs required to define, design and plan the collaborative initiative
- Capital costs of investments required to develop and implement the initiative
- Training costs required to enable staff to operate new systems and procedures
- Social costs - the new collaborative arrangements may involve the need for staff to relocate or be redeployed

In addition costs and benefits to other parties, and to the environment have also been considered. In the case of the FABEC, the relevant parties comprise:

- Air navigation service providers in the FABEC States, both civil and military
- Airspace users, of the airspace in the FABEC States, both civil and military
- The administrative apparatus of the States
- Consumers of air transport (passengers and freight customers)
- The general public (who are affected by environmental and safety costs and benefits)

In practice, a lack of information meant that the quantitative part of the analysis was confined to civil ANSPs and civil airspace users. These are likely however to comprise the vast majority of the impacts of the project. Impacts of military users, military service providers, and State administrations were considered qualitatively; and the impact on consumers of air transport is considered to be subsumed in that on commercial airspace users.

Safety is considered to be a paramount constraint. Changes which might diminish safety levels are not considered, and therefore it is assumed that safety provides a net benefit that is at worst zero.

G.2 Working method

The approach to producing the cost-benefit analysis was as follows:

- Define the scope and parameters of the cost-benefit analysis, including the price base, discount rate, time horizon of the analysis, the range of stakeholders to be considered, the method of valuing user benefits and the performance indicators to be assessed
- Determine the features of a 'reference case' – this is the description of what the situation would be in air navigation service provision in the FABEC States if international collaboration remained at the levels planned before the initiation of the FAB project
- Define a list of proposed 'FAB initiatives' – these are cooperative projects that result from the FAB and, it is hoped, bring net benefits to the stakeholder community
- Determine as far as possible the costs and benefits of these initiatives
- Summarise the overall impact of the FAB initiatives, both in terms of their net benefits, and in terms of their impact on performance indicators for the FAB

G.3 Reference case

A key element of any cost-benefit analysis is a 'reference case'. This should be a realistic assessment of what the future scenario would be in the absence of the project. In the case of FABEC, this is the situation in which cooperation between ANSPs continues at similar levels to those in the past.

The reference case was determined as far as possible from the forecasts and plans of the individual ANSPs. The Local Convergence and Implementation Plan for each State were examined along with individual ANSPs' submissions to the PRU of forward projections in the context of ACE 2006, and further information provided in consultation with the ANSPs. The traffic forecast developed for the feasibility study was also used.

The specification of the reference case comprises the trajectories over time of the following variables:

- Traffic
- Capacity
- ATCO hours
- Delays
- Flight efficiency
- Investment
- Costs, and consequently
- Performance indicators

The LCIPs and ACE submissions, as well as ANSP business plans, where available, have a much shorter time horizon than that of this cost-benefit analysis – typically 2010 for ACE and 2012 for the LCIPs. Therefore a method of extrapolation beyond the time horizon of the LCIPs was agreed. The basic approach was to assume the trajectory of chosen performance indicators, and to infer the development of cost variables from there.

The following paragraphs discuss each of the variables in turn.

G.3.1 Traffic

Between 2005 and 2015, the annual average growth rate is expected to be 3.7%; thereafter 2.5%.

It was assumed that the traffic growth in terms of flight-hours (the variable that, according to the PRU framework, best measures the output of en-route ANS) is the same as that in movements. Therefore it is assumed that the average time spent by a movement in FABEC airspace is unchanged over the period.

G.3.2 Capacity

The FABEC ANSPs are expecting to continue to increase capacity even without the FABEC initiatives. This increase in capacity is due to further improvements to procedures and systems that do not require cooperation with neighbouring ANSPs. However, these capacity increases are likely to be facilitated by closer cooperation with neighbours and may be achieved earlier within a cooperative environment.

The capacity increases in the reference case, planned by the ANSPs, have been obtained from the LCIPs for each State. They provide information up to 2012. From 2013 onwards it is understood that the major benefits of improving systems and procedures for each ANSP working independently will have been achieved, with further significant gains in capacity considered to be unlikely without cooperation with neighbouring ANSPs. Therefore, from 2013 onwards the capacity increases available in the reference case were estimated by detailed investigation into the capacity constraints that are foreseen at each en-route operational unit in FABEC, looking in particular at scope for increased capacity through sector subdivision and constraints on the recruitment and qualification of ATCOs. These assumptions resulted in a capacity growth of between 3% and 3.4% per year after 2013.

A second capacity growth scenario was proposed within the feasibility study, which assumed a more pessimistic rate of capacity growth being available from 2013. This assumed that the rate of growth was approximately 2% per year in most operational units, apart from Karlsruhe UAC, where a low level of growth up to 2013 allied with the new VAFORIT system is expected to enable a 3% growth from 2013 onwards. The impact of the pessimistic capacity growth on the results of the cost-benefit analysis was presented as a sensitivity analysis.

G.3.3 ATCO hours

The number of ATCO hours required to handle the traffic is determined by the ATCO productivity. ATCO productivity is defined as the number of flight hours controlled per ATCO hour on operational duty.

A reasonable assumption for long term planning was deemed to be a constant value, although in some ANSPs there may be pressure for the average hours on duty to be reduced. For the purposes of these projections a constant value of approximately 1350 hours (the average in 2005) for the entire period was assumed.

This assumption infers that for the period 2005-2010, ATCO productivity in the ANSPs' plans will improve by about 2.3% per year.

Beyond 2010 it was assumed that ATCO productivity would continue to increase but at a diminished pace. The rationale is that the sources of important productivity gains that are exploited during 2005-2010 will become thinner, and that 'business as usual' improvements over a long term period are more realistically around 1%. This reduced rate of increase reflects in addition the diminishing returns to sector subdivision.

The reference case projections also account for constraints on recruitment and qualification of ATCOs. Some ANSPs within the FAB are not able to recruit as many ATCOs as they need to provide sufficient ATCO hours on duty to cope with the traffic demand. Furthermore, even if there are no direct constraints on the number of ATCOs that can be recruited, the duration of the training process means that there can be a deficit in the number of controllers required to man the sector opening schedule. This is particularly the case during periods of high growth in traffic demand where ANSPs have difficulty in keeping recruitment and qualification in line with the increase in traffic.

It was assumed that if the number of ATCO hours required is greater than the number of ATCO hours available then there will be a deficit of sectors available during peak hours, which results in ATFM delay.

G.3.4 Delays

If capacity falls short of that required to meet demand, delays will ensue.

The level of delay in the future has been estimated by examining the relationship between the demand/capacity ratio (averaged over a year) and the delay.

A methodology for analysing the relationship between demand, capacity and delay was developed for the Franco-Swiss FAB, which focused on Zurich ACC. The Franco-Swiss methodology demonstrated that the relationship between daily delay at Zurich ACC and the ratio between capacity and demand gave rise to a relationship between annual demand and delay. Delays for other ACCs were not sufficiently widespread to be able to confirm the applicability of this relationship elsewhere.

The annual delay figures for all ACCs were examined in the FAB for the years 2003 to 2006, assuming that the Zurich equation applied, but with a different capacity. It was possible to derive equations that fitted observed annual figures at all 14 ACCs.

The model was adjusted to ensure that it produced 2006 delay figures, so that growth in capacity started from an accurate baseline. An exponential relationship between the demand/capacity ratio and the amount of delay generated was derived.

The exponential relationship appeared to apply over a wide range of demand/capacity ratios. It could not, however, be extrapolated indefinitely. After a certain point, delays will not be tolerated by users and flights will be cancelled or diverted. There was no recent evidence, however, of the magnitude of this effect, since delays in recent years have not been of such magnitude to generate appreciable quantities of such 'unaccommodated demand'. It was not possible to gain access, either, to simulations that would give guidance on the likely magnitude of the effect. Nevertheless, it was felt that it was an important effect to include in the analysis. Simple extrapolation of the delay curve beyond the point for which there is evidence could give unrealistic results, especially as the reference case was one in which there were serious shortages of capacity. Therefore expert judgement was used to estimate how that curve would continue.

It was assumed that unaccommodated demand would become appreciable when annual demand exceeds capacity by 15% (a demand/capacity ratio of 1.15). Furthermore, it was assumed that where demand exceeds capacity by more than 30% (a demand/capacity ratio of 1.3), no further demand can be accommodated. The resulting relationship between the demand/capacity ratio, delay and unaccommodated demand is shown in Figure 40.

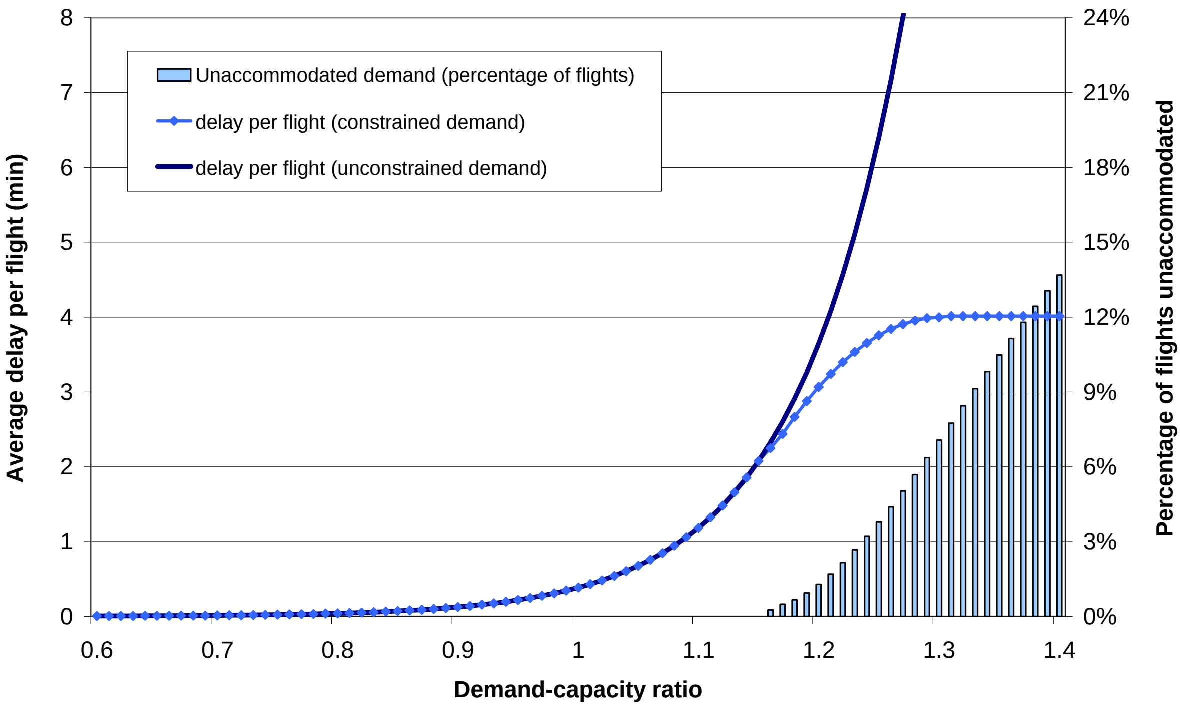

Figure 40 Delay per flight and unaccomodated demand

It should be emphasised that this curve is simply one possibility. The choice of curve is a matter of judgement, rather than inference from evidence or from simulations. A range of possible relationships would be consistent with both observations and with the features of the system.

The growth in ACC capacity was then projected for each ACC. The ratio of demand to capacity and the relationship derived above enabled the estimated projections of delay.

The expected evolution of the average annual en-route ATFM delay per flight from 2007 to 2025 is presented in Figure 41. It shows that the delay per flight is projected to increase steadily until 2015, where capacity constraints begin to take hold and the delay per flight increases at a greater rate. This is because ANSPs have identified some capacity constraints, and have also stated that initiatives to improve performance in the short to medium term take time to implement. Whilst these initiatives are being developed and implemented, the level of delay increases. Once delay increases beyond a certain value, the cost of the delay will mean that they will not actually operate as many flights as they wish to. The flights which are cancelled or that are not scheduled constitute what is known as unaccommodated demand. Once demand cannot be accommodated, the level of ATFM delay does not increase further, but there is a cost associated with airlines not being able to operate as many services as planned.

The estimation of delay per flight represents a ‘best case’ scenario. It relies on the ANSPs implementing the capacity enhancing measures that they have indicated are available throughout the period of the analysis.

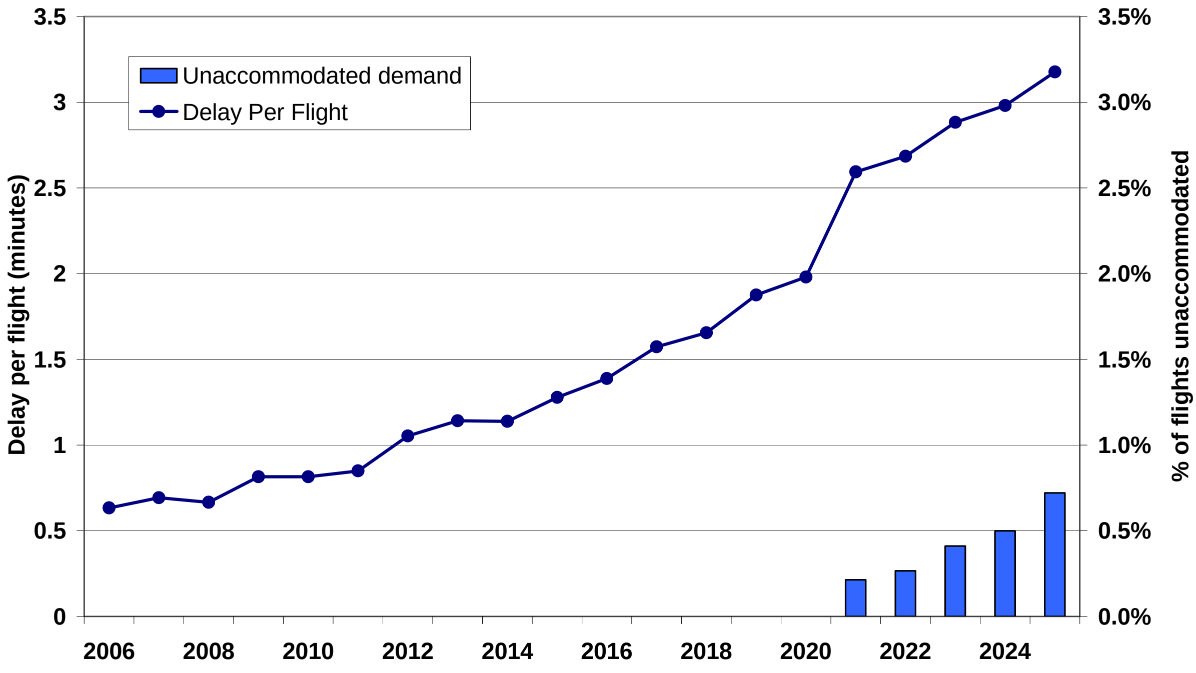

Figure 41 Delay per flight and unaccomodated demand in the reference case

The average en-route ATFM delay per flight is projected to rise from 0.7 minutes per flight in 2006 to 2.5 minutes per flight in 2020. The rise in average delay per flight is driven by the bottlenecks at Maastricht UAC and Karlsruhe UAC in the core area, where capacity constraints will develop over the coming years. The level of delay is expected to remain at similar levels to 2006 in other ACCs where capacity is understood, according to information obtained, not to be constrained.

G.3.5 Flight efficiency

Simulations performed for the feasibility study have estimated that the average excess route length of flights in the FABEC area was 5.6%. This compares with 4.2% estimated by the PRU for Europe as a whole.

The simulations also showed that, in the absence of a FAB, flight efficiency will worsen in the future. This is expected because deviations from the optimum route in the FABEC airspace do not arise principally from inefficient routing that can be improved by better route design. Rather it arises from the presence of military segregated areas. The simulations show a worsening of the excess route length indicator by 9%, to 6.1%, by 2018.

G.3.6 Costs

ATCO employment cost

In 2001-2006 the average ATCO employment cost per ATCO-hour for FABEC ANSPs rose by about 2.0% per year in real terms. These figures were extrapolated and it was assumed that the employment costs per ATCO-hour increase at 2% per year until 2011.

Discussions indicated that in the longer term a 2.5% growth per year would be plausible. Therefore, it was assumed that the rate of growth increases linearly after 2011; reaching 2.5% in 2016 and remaining constant thereafter.

Non-ATCO staff cost

Between 2006 and 2011, the non-ATCO staff cost is inferred as the difference between the total staff cost (as declared in ACE submissions and in LCIPs) and the employment cost for ATCOs in OPS (estimated above). In 2006 this was €750m.

From 2012 onwards, it was assumed that ANSPs would be able to hold the number of non-ATCO staff constant, despite increases in traffic.

The breakdown of non-ATCO staff in FABEC was analysed to inform the assumption of the evolution of non-ATCO staff cost after 2011. The analysis showed that ATCOs in OPS account for 29% of the overall workforce. ATCOs on other duties (including ab-initio trainees and on-the-job trainees) account for 11% of the total workforce. Technical support staff account for 33% of the workforce with administrative and ancillary staff accounting for 14%. The remaining 13% comprises non-ATCO support staff, ATC assistants and other staff.

Given the breakdown of staff, it was realistic to assume an increase in the unit employment cost per non-ATCO staff member, but to a lesser extent than for ATCOs. An increase of 1.5% per annum was assumed, in real terms, in the average unit employment cost.

Non-staff operating cost

Between 2006 and 2011, the non-staff operating cost was assumed to be as planned by ANSPs in their ACE submissions and LCIPs. From 2012 onwards, it was assumed that the support cost would increase at the same rate as the number of ATCO-hours. In 2006, non-staff operating costs amount to €255m; they rise to €359m in 2025.

Total ATM/CNS cost

The total ATM/CNS cost is as planned by ANSPs up until 2011, and is the sum of the cost categories presented above, plus the depreciation and interest cost.

By 2025, the overall increase in ATM/CNS cost (51%) is significantly lower than the expected increase in traffic (+74%). The trends projected are consistent with the recent past and with ANSPs' plans.

The reference case embodies an improvement in financial cost effectiveness of around 9% by 2018. This reference case is far from a 'do-nothing' case as it relies on important, continuing productivity gains, while the support costs are contained at lower levels than the increase in traffic growth.

The economic cost effectiveness was also analysed. The economic cost effectiveness shows the cost of ANS provision per flight hour and also accounts for the estimated cost of delays and flight inefficiency to airspace users. The rising delays in the reference case mean that the improvements in financial cost effectiveness noted above (9%) are offset by increased costs to users as a result of a decline in the quality of service to users, through increased delay and a reduction in flight efficiency.

G.4 The scenarios considered

The FABEC initiatives are, in broad terms, a set that can realistically be implemented by the FAB's participating ANSPs over the next 10-12 years, using models of financial and economic cooperation that rely on contractual relationships between the ANSPs. Such cooperation could take the form of a contractual agreement between ANSPs ('contractual cooperation model'), or alternatively the ANSPs could create an alliance which would provide a greater level of cooperation ('alliance model'), with some joint bodies making decisions in key areas.

A further set of initiatives was investigated that can be broadly classed as ’more ambitious’ than those included in the models discussed so far. The initiatives discussed are for the most part associated with a closer model of institutional cooperation, which has been described as a ’single ANSP model’. However, they also include further cooperation among civil and military ANSPs, and increased focus on economic efficiency in relations with other parties such as MET service providers.

Due to the level of information available, the cost-benefit analysis focused on the alliance model. The contractual cooperation model is considered to be similar to that of the alliance model, except it has an increased level of risk in terms of cost and timescales for implementation. This is due to the additional consultation that may be required between participating ANSPs compared to an alliance.

G.5 FAB initiatives and their characteristics

The FAB initiatives analysed in the cost-benefit analysis are presented in Section 5. In summary they comprised:

- Improvements to the operational concept and concomitant improvements to airspace design, producing:
    - short term gains in ATCO capacity and productivity through cross-border sectorisation
    - gains in flight efficiency through optimisation of military use of airspace
    - progressive further gains in ATCO productivity, sector capacity, and flight efficiency through the introduction of elements of the new operational concept
- Improved ATM infrastructure and related technical support, producing cost savings through convergence on common ATM systems, and through common procurement
- Improved CNS infrastructure and related support, producing cost savings through joint planning, procurement, and service provision
- Common training and qualification of personnel, producing cost savings
- A cooperative approach to the provision of AIS, producing cost savings
- An improved more cost-effective way of using and sharing MET information, resulting in the reduction of weather-related delays
- A more cost-effective way of providing the level of contingency coverage specified by the States as their collective response to the requirement of the SES, producing cost savings
- A single unit rate in the FABEC airspace, removing incentives to use longer routes to minimise route charges, and therefore improving flight efficiency

The above benefits were associated with the alliance institutional model.

In addition, some additional ‘more ambitious’ initiatives were considered that were likely not to be achievable without closer institutional models of the single ANSP type – such initiatives comprised:

- Closer cooperation on the provision of ATM infrastructure, not ruling out possible net cost savings from reduction in the number of operating units
- Reduction in some elements of central overheads.

However, it was recognised that substantial transition costs might be associated with such moves, as well as pressures to increase levels of costs caused by merging organisations.

Some further impacts were not quantified, including:

- The impact of improved vertical flight efficiency, predictability and punctuality (over and above the impact from delay reductions and the reduction of unaccommodated demand)
- The costs to military users of re-locating their training areas
- The benefits to the military of improved civil/military and military/military coordination that might be brought about by ambitious models of cooperative civil/military service provision
- The impacts on States' administrative and regulatory apparatus, where short term costs arising from the change might be followed by long term benefits in coordinated and cooperative approaches to regulation

For each FABEC initiative, the likely magnitude and timing of the benefits was assessed. An assessment of the transition costs was also made, including the required set-up costs, training costs, and the investment required to bring the initiatives about.

G.6 Results of the cost-benefit analysis

The analysis shows, on the assumptions made for the alliance model, that the corresponding FABEC initiatives will bring substantial benefits. In the short term, these will largely comprise reductions in delay, caused by resectorisation in particular in the 'hotspots'. In the longer term, further benefits in terms of further delay reductions, reductions in unaccommodated demand, and saved ANSP costs will be added, achieved through an increase in ATCO productivity, as well as improvements in flight efficiency caused by improved airspace design.

The detailed outcome of a number of major FAB initiatives could be taken either as reduced delay, through providing more capacity; or as reduced costs. Our base case is based on the assumption that the FAB as a whole aims for an average delay of approximately 0.5 minutes per flight. It is believed that this target is consistent with the Provisional Council's target of 1 minute per flight, since the latter target is for summer, when delays are generally greater, and applies to Europe as a whole rather than just FABEC. The consequences of aiming for a less ambitious delay target have been examined. Aiming for a target in the FAB of 0.75 minutes results in a major shift of benefits from delay savings to cost savings. The overall benefits of the project are, however, substantially lower.

The benefits achieved from reducing the delay are presented in Figure 42.

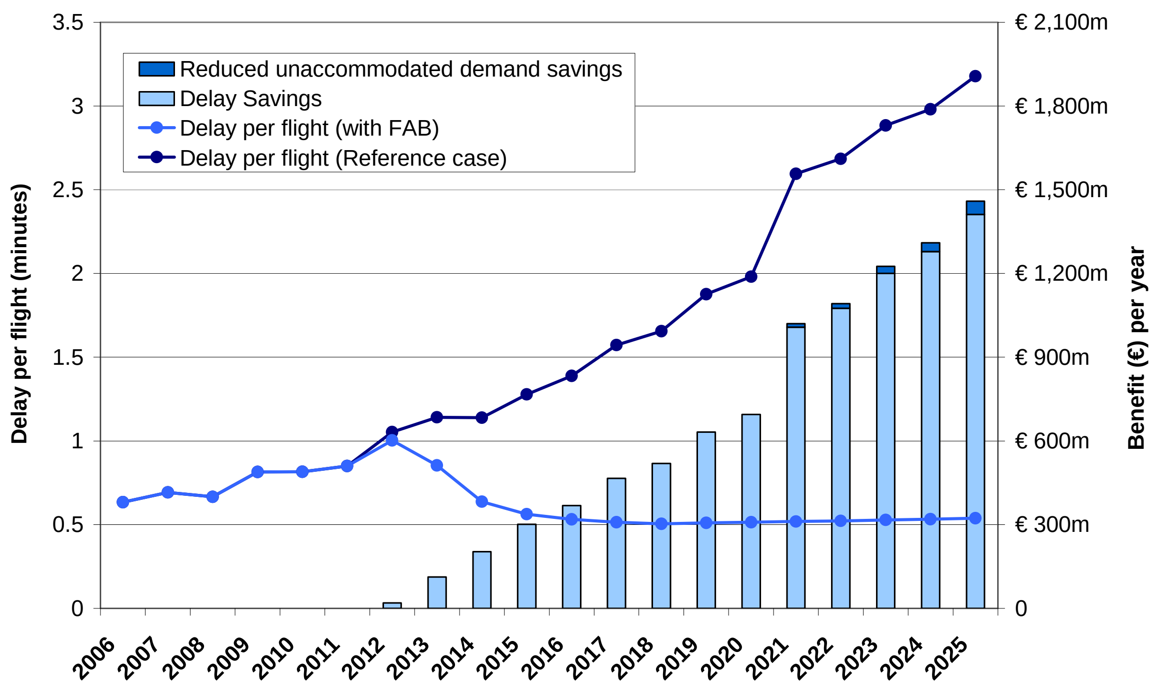

Figure 42 Delay per flight benefits

The value of reducing the level of delay and unaccommodated demand is estimated to be €200m a year in 2014, rising to €880m in 2020 and €1,420m in 2025.

Figure 43 presents a summary of the annual change in benefits over time for both the indirect benefits and the direct benefits to users.

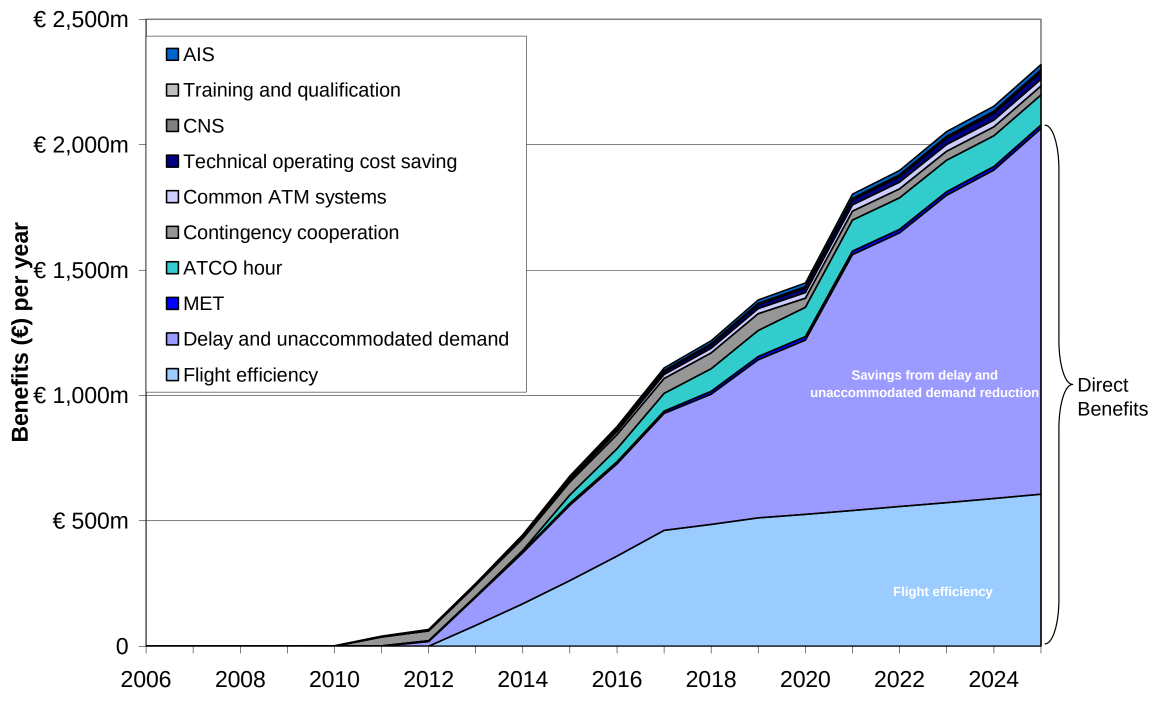

Figure 43 Overall annual benefits over time

G.6.1 Discounted cash flow

The results of a cost-benefit analysis are conventionally presented as a discounted cash flow. This takes into account the relative value of present and future costs and benefits by using a 'discount rate'; the value of equivalent benefits one year later are reduced by the discount rate.

The discounted cash flow calculation sums the net benefits of the project over its history, with costs and benefits in each successive year appropriately discounted. The Net Present Value (NPV) of the project is the sum of these discounted cash flows for the life of the project.

Table 19 presents the NPVs of the project cash flows taking into account net benefits to a number of time horizons. It shows:

- The present value (PV) of the direct user benefits - the savings in delays and flight efficiency gains
- The net present value (NPV) of the ANSPs' cash flow
- The sum of these - the NPV of the project as a whole

	Direct benefits (PV)	NPV of ANSPs' cash flow	Project NPV
2014	€ 376m	€ 195m	€ 571m
2020	€ 3,147m	€ 685m	€ 3,832m
2025	€ 6,196m	€ 1,099m	€ 7,295m

Table 19 Present value of FAB initiatives

G.7 Cost effectiveness

Figure 44 presents the financial cost effectiveness performance once the FAB initiatives have been taken into account, compared to the reference case. It shows that the FAB initiatives identified make an important contribution in enhancing moves towards greater financial cost effectiveness.

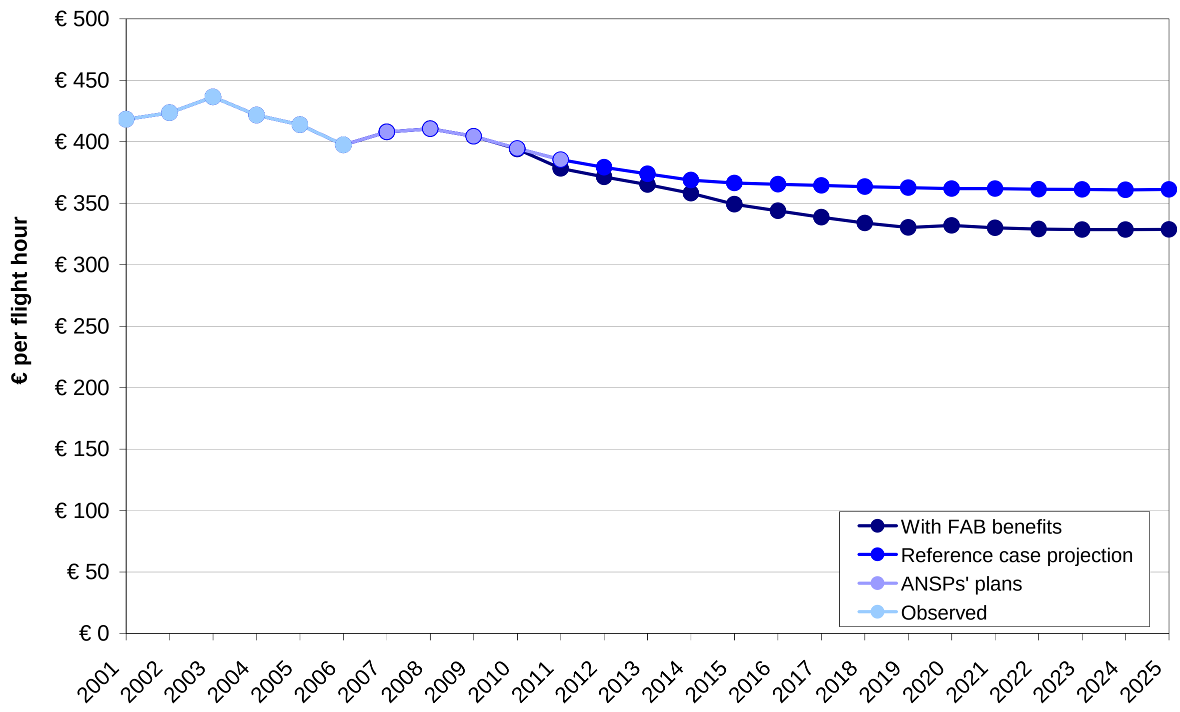

Figure 44 Financial cost effectiveness performance with and without the FAB

Figure 44 also shows that after 2014 the financial cost effectiveness stabilises in the reference case, with only a marginal improvement from 2014 to 2025. This shows that additional measures, such as the FAB initiatives, are required to provide further improvements in financial cost effectiveness after 2014.

The reference case, which relies on continuing improvements without the FAB embodies a 9% reduction in en-route cost per flight hour by 2018. The FAB initiatives contribute to an overall reduction of 17% by 2018, achieving the target of a 17% reduction in en-route cost per flight hour. After 2018, the financial cost effectiveness continues to improve, and by 2025, shows a reduction of 21% in the en-route cost per flight hour.

Figure 45 presents the economic cost effectiveness indicator both for the reference case and also for the 'with-FAB' case.

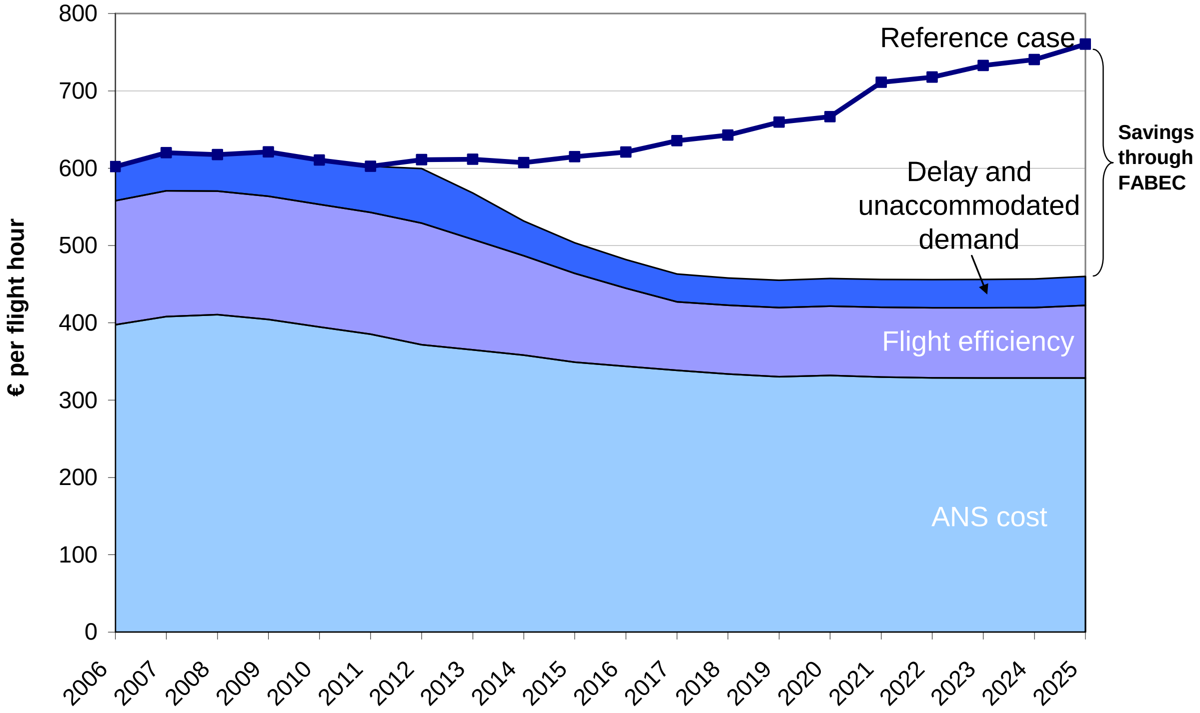

Figure 45 Economic cost effectiveness indicator

Figure 45 shows that despite the reduction in the ANSP cost per flight hour predicted in the reference case the increase in delay, increase of unaccommodated demand and the deterioration of flight efficiency results in a lower economic cost effectiveness in 2025 compared to 2006. It also shows that the FAB initiatives provide a significant improvement to the economic cost effectiveness, reducing the economic cost per flight hour by 38% in 2025 compared to the reference case.

G.8 Sensitivity analysis

The sensitivity of the cost-benefit analysis to the following variables was analysed:

- Capacity growth after 2012 corresponding to the pessimistic capacity growth scenario
- Traffic demand being lower than anticipated
- Uncertainty in the benefits of the operational and technical initiatives
- The impact of the ATFM delay target on the NPV
- The impact of the discount rate on the NPV

The results are sensitive to the input assumptions. The project NPV remains positive in all cases, however. The analysis is most sensitive to the magnitude of delay in the reference case, which is influenced both by the capacity growth and the traffic demand. The analysis has shown that the FAB initiatives will overcome the capacity constraints, however, the scale of the benefits and to whom the benefits are apportioned is sensitive both to the rate of traffic growth and to the degree to which capacity can be expended in the reference case.

The sensitivity analysis has shown that in 2025 the NPV for the FABEC project could range from €3,600m to € 9,800m, with the NPV most likely to be in the region of €7,000m.

G.9 FABEC scenarios of institutional cooperation

The FAB scenario currently analysed in the cost-benefit analysis comprises a series of cooperative initiatives which will bring benefits, either in their own right or by enabling other beneficial cooperative actions.

So far, it has been assumed that the initiatives will be implemented under an alliance structure. A contractual agreement of some kind is considered necessary as some of the cooperative initiatives will be difficult to obtain without certain key changes, notably a move towards revenue sharing which is not based on traffic.

The model investigated so far, involving a contractual structure, but with one or more joint decision making bodies with delegated power in defined areas, appears to be consistent with the 'alliance' model put forward by the seven ANSPs. This chapter looks at the different cooperation models in order to answer two main questions:

- Are there further beneficial initiatives that could be accomplished in a more integrated institutional model; a 'single ANSP' model?
- What would be the potential impact of relying contractual cooperation ('contractual cooperation' model), rather than forming an alliance?

G.9.1 Single ANSP model

A number of additional initiatives might be possible under the single ANSP institutional model. A detailed examination of these initiatives was not undertaken by the project, and substantial extra work would be required to specify the characteristics of such initiatives, and evaluate them. This section discusses the potential initiatives and quantifies possible impacts only in the broadest possible terms. A single ANSP would be free to plan the expansion and replacement of its operating units, and particularly its ACCs, without reference to national boundaries. This would allow over the course of time for a planned **reduction in the number of operating units**. Such a reduction would be likely to bring benefits, since there are substantial fixed costs associated with an ACC, and a number of the existing ACCs are likely to be below optimum size.

The fragmentation study [Ref. 10] carried out by the Performance Review Council estimated the costs of fragmentation in European ATM and CNS. The methodology employed a model of the capital and operating costs of ACCs derived from a combination of empirical evidence and the consultants' expert judgement and experience.

This analysis was used to estimate the impact of a reduction in the number of centres. The overall reduction in costs could be in the region of €30m to €40m per annum for each operational unit that is closed. Closing operational units may also make the capacity targets more difficult to achieve.

It is important to note that there is an element of double counting between this area of benefit and that from common systems. Put simply, the fewer centres there are, the less the benefit from common systems.

These benefits will take a long time to achieve in full. The time required for the major programmes of rationalisation and consolidation in the UK and Germany required 10 years or more. For the purposes of this analysis, it was assumed that the benefits are phased in gradually over the period 2014 to 2023.

Transition costs for this initiative could well be high. Social costs, arising from the need for staff redeployment, relocation and redundancy, would probably be a more important element than capital costs of expanding centres. It is estimated that the social costs would be in the tens of millions.

Training costs would also be very substantial. Overall transition costs are also likely to be in tens of millions. Without a more concrete specification of the nature of the consolidation that could occur, it is impossible to assess in any detail what their order of magnitude would be. Furthermore, closure of one or more centres might create difficulties in providing the expended capacity needed.

A single ANSP would allow economies of scale to be achieved in certain **central overhead costs.** Examples might be finance, HR, legal, general management. It is estimated that establishment of a single ANSP and the resultant consolidation of administrative functions could result in a reduction in central overhead costs amounting to €10m, per centre closed.

In addition to the major benefits noted above, a single ANSP may also:

- Achieve faster and more cost-effective **convergence on technical systems**, particularly ATM systems. Its effectiveness in securing the benefits of **common procurement** might also be greater.
- Be relieved from the constraint of purchasing MET services from a national provider, and thus achieve substantial **economies in MET costs**.
- Encourage national governments to cooperate in regulation, and delegate regulatory/NSA services to a single body. This would be likely to yield **savings in regulatory costs.**

As well as the benefits of the single ANSP institutional model, another element of a more ambitious scenario might be increased military-military cooperation - again, substantial benefits might be achievable.

The costs and benefits of reducing the number of training centres in FABEC were also discussed. However, the estimates of the costs and benefits that may be involved were at a high level, and were not detailed enough to provide an estimate of the benefits.

The further benefits of this ‘single ANSP’ model are apparent largely as improvements in financial cost effectiveness. As shown the initiatives that are included in the ‘alliance’ model are already sufficient to remove most of the capacity and delay problems that could emerge over the period of projections.

G.9.2 Contractual cooperation model

The understanding is that all of the initiatives discussed in Chapter 5 are feasible under a model of contractual cooperation as well as under an alliance. However, the nature of contractual cooperation is expected to increase the risk of delaying the implementation of the FAB initiatives. This delay is likely to be due to the requirement to refer individual decisions regarding the FAB initiatives to each ANSP for agreement. Such a process may result in lengthy delays to implementation which could impact in the following ways:

- Increased project risk
- increased time taken to implement initiatives
- increased implementation costs
- achieving the benefits will be delayed

A quantitative analysis of the impact of such delays was not undertaken.