SESAR Definition Phase - Deliverable 5

SESAR consortium

# SESAR Master Plan

# D5

DLM-0710-001-02-00 April 2008

EUROCONTROL

SESAR consortium

# SESAR Ex Com
## 21st Decision Note – Ref: MGT-0803-001-01-00

We, Representatives of the Global Consortium Members within the SESAR Executive Committee, hereby approve the following D5 document for submission to the Purchaser ("EUROCONTROL") by the Project Directorate:

Document D5

Document No: DLM-0710-001-02-00 (accepted document)

Document Title: SESAR Master Plan

Brussels, April 2008

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Issued by the SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL

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The SESAR Consortium joins the forces and expertise of 29 companies and organisations together with 21 associated partners: from Airspace Users, Air Navigation Service Providers, Airports, Supply Industry and many others, including Safety Regulators, Military, Pilots & Controllers Associations and Research Centres as well as significant expertise from EUROCONTROL.

# Preface

The SESAR programme is the European Air Traffic Management (EATM) modernisation programme. It will combine technological, economic and regulatory aspects and will use the Single European Sky (SES) legislation to synchronise the plans and actions of the different stakeholders and federate resources for the development and implementation of the required improvements throughout Europe, in both airborne and ground systems.

The first phase of SESAR, the Definition Phase, is co-funded by EUROCONTROL and the European Commission under Trans European networks. The products of this Definition Phase will be the result of a 2-year study awarded to an industry wide consortium supplemented by EUROCONTROL's expertise. It has delivered the SESAR Master Plan covering the period up to 2020 and the accompanying Programme of Work for the first 6 years of the subsequent Development Phase.

The SESAR Definition Phase will produce 6 main Milestone Deliverables (DLM) over the 2 years covering all aspects of the future European ATM System, including its supporting institutional framework. The scope of the 6 Deliverables (Dx) are:

- D1: Air Transport Framework – the Current Situation;
- D2: Air Transport Framework – the Performance Target;
- D3: The Definition of the future ATM Target Concept;
- D4: Selection of the "Best" Deployment Scenario;
- D5: Production of the SESAR Master Plan;
- D6: Work Programme for 2008 –2013.

The SESAR Consortium has been selected to carry out the Definition Phase study, which for the first time in European ATM history has brought together the major stakeholders in European aviation to build the SESAR Master Plan. The SESAR Consortium draws upon the expertise of the major organisations within the aviation industry. This includes Airspace Users, Air Navigation Service Providers (ANS Providers), Airport Operators and the Supply Industry (European and non-European), plus a number of Associated Partners, including safety regulators, military organisations, staff associations (including pilots, controllers and engineers) and research centres who work together with the significant expertise of EUROCONTROL. This is considered to be a major achievement.

**It must be noted that SESAR Definition Phase is a feasibility study, some long term results of which (e.g. the technology platforms) should be further validated and consolidated during the next SESAR phases before Stakeholders could effectively implement its outcome in a concrete way.**

This fifth Deliverable, D5, has been produced in accordance with its Milestone Objective Plan (MOP) [Ref 1] with inputs from the seven Task deliverables which are providing the substantiating information and which are identified within the SESAR Work Breakdown Structure. D5 has subsequently been approved and accepted by all Project Participants.

**The SESAR Consortium members:**

AEA (Association of European Airlines), ADP (Aéroports de Paris), AENA (Aeropuertos Espanoles y Navegacion Aérea), AIRBUS, Air France, Air Traffic Alliance E.I.G/G.I.E, Amsterdam Airport SCHIPHOL, Austro Control GmbH, BAA Ltd, BAE Systems, DFS Deutsche Flugsicherung GmbH, Deutsche Lufthansa AG, DSNA (Direction des Services de la Navigation Aérienne), EADS (European Aeronautic and Space Company), ENAV S.p.A. (Società Italiana per l'Assistenza al Volo), ERA (European Regions Airline Association), FRAPORT, IAOPA (International Council of Aircraft Owner and Pilot Associations), IATA (International Air Transport Association), Iberia, INDRA Sistemas SA, KLM (KLM Royal Dutch Airlines), LFV (Luftfartsverket), LVNL (Luchtverkeer Nederland), Munich International Airport, NATS (National Air Traffic Services), Navegaçao Aérea de Portugal (NAV), SELEX Sistemi Integrati, THALES Air Systems S.A., THALES AVIONICS.

**The SESAR Associated Partners:**

ATC EUC (Air Traffic Controllers European Unions Coordination), Boeing, CAA UK (Civil Aviation Authority UK), ECA (European Cockpit Association), ELFAA (European Low Fare Airlines Association), ETF (European Transport Workers' Federation), EURAMID (European ATM Military Directors), IFATCA (International Federation of Air Traffic Controllers' Associations), IFATSEA (International Federation of Air Traffic Safety Electronics Association), Honeywell, Rockwell-Collins, Dassault Aviation (representing EBAA). Research Centres: AENA (Aeropuertos Espanoles y Navegacion Aérea), DFS Deutsche Flugsicherung GmbH, DLR (Deutsches Zentrum für Luft – und Raumfahrt), DSNA (Direction des Services de la Navigation Aérienne), INECO (Ingenieria y Economia del Transporte, S.A.), ISDEFE (Ingenieria de Sistemas para la Defensa de Espana), NLR (Stichting Nationaal Lucht- en Ruimtevaartlaboratorium), SICTA (Sistemi Innovativi per il Controllo del Traffico Aereo), SOFREAVIA (Société Française d'Etudes et de Réalisations d'Equipments Aéronautiques).

# Executive Summary

## The SESAR Master Plan is coordinating the ATM future of Europe

The content of this SESAR Master Plan (further referred to as the Master Plan) builds upon the material contained in Deliverables D1, D2, D3 and D4 to provide a plan for implementing the ATM Target Concept addressing deployment and R&D planning in terms of roadmaps for Operational Evolutions, Enabler Development & Deployment and Supporting Aspects. These roadmaps encompass the lifecycle between feasibility up to and including deployment and are supported by an analysis of the associated Benefits, Funding and Financing aspects as well as the related risks. Both the time component of the roadmaps and the associated benefits are critical for the success of the future phases of the SESAR programme. It is important that the core components of the ATM Target Concept are implemented timely and consistently at European network level to enjoy their full benefits. It is recommended that this timely implementation will be supported by innovative incentive and/or penalty mechanisms to provide the best opportunity cost for all stakeholders to quickly adopt the system.

All three elements of the Master Plan, the "High Level View" (D5), the "Planning Area" and the "Agreed and Committed Implementation Activities" (renewed ECIP/LCIP process) provide the necessary set of planning means to ensure the successful implementation of the ATM Target Concept.

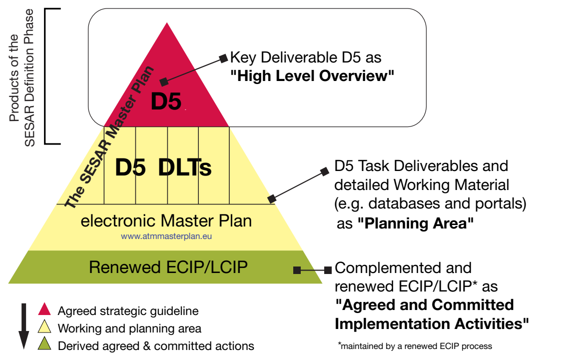


Figure 1: Structure of the Master Plan

## Structure of the Master Plan – from agreed High Level View to Committed Action

D5 represents the High Level Overview of the Master Plan. It is the agreed strategic guideline delivered by the SESAR Consortium. It identifies necessary activities on a stakeholder group level.
This High Level Overview is accompanied by working material, which contains more detailed information. The working material comprises the Task Deliverables of the SESAR Consortium and the Master Plan Database which is being migrated into the electronic Master Plan, the electronic Master Plan portal which can be found at the following web address: www.atmmasterplan.eu.

This working material serves as a "Planning Area" from which specific R&D and individual implementation activities will be derived and agreed. Once agreed and committed implementation activities will be captured and monitored through a renewed ECIP/LCIP process. The ECIP planning material provides the third element of the Master Plan.

## The ATM Target Concept – from validation to implementation

The ATM Target Concept describes the main areas and directions of progress to be made. The specific and detailed changes (called "operational improvements [OI] steps)") required to transition from today's system have been structured in a series of ATM Service Levels (0-5)[1] and organized in Implementation Packages 1-3 depending upon the date at which the corresponding capability can become operational (Initial Operational Capability (IOC) date):

- IP1 – Implementation Package 1 (short-term: IOC dates up to 2012)
  - Covers ATM Service Levels 0 and 1
- IP2 – Implementation Package 2 (medium term: IOC dates in the period 2013-2019)
  - Covers ATM Service Levels 2 and 3
- IP3 – Implementation Package 3 (long term: IOC dates from 2020 onwards)
  - Covers ATM Service Level 4 and 5.

[1] The notion of ATM capability levels had already been introduced in D3. Please note that the definition of some levels has been changed in D5.

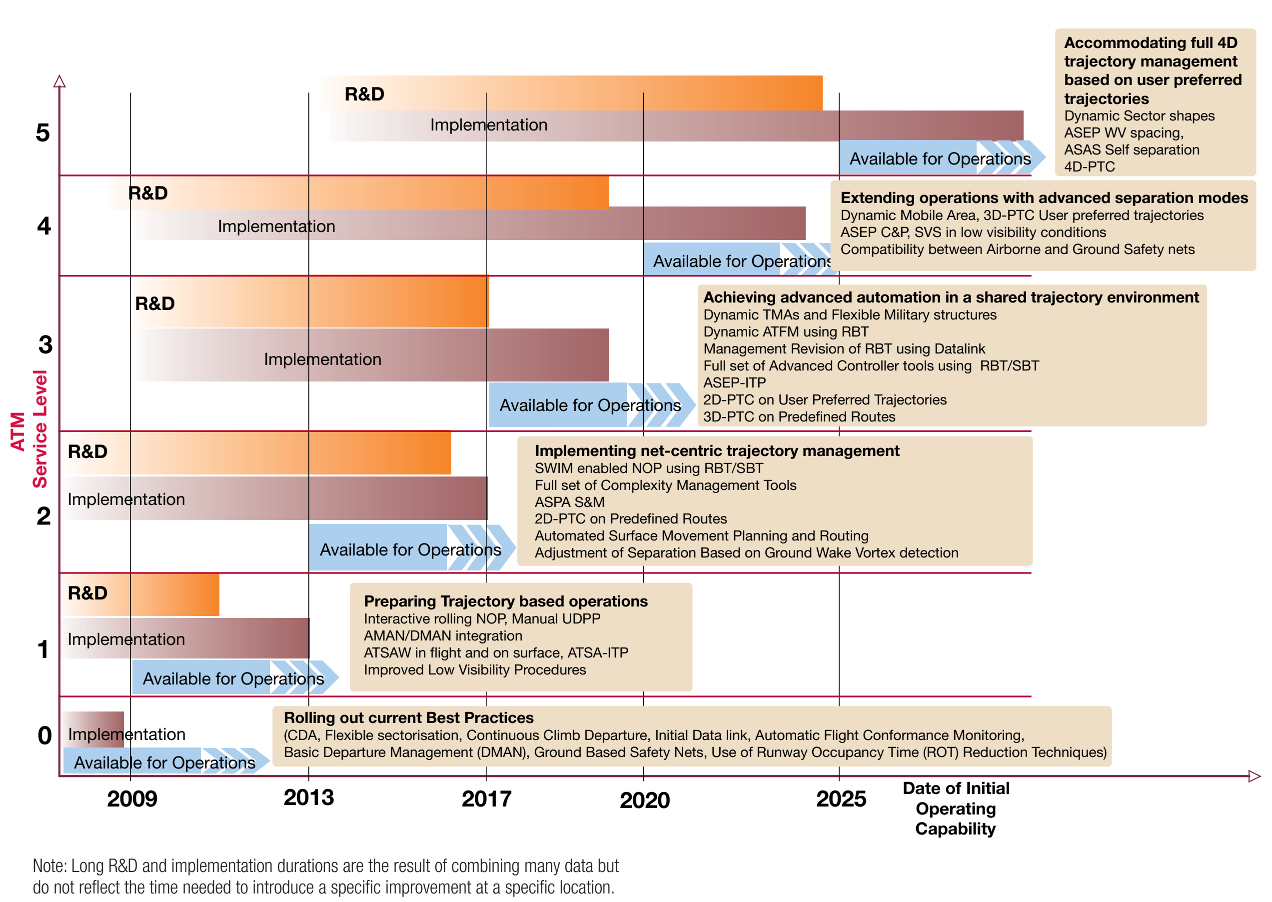


Figure 2: Master Plan Overview

The R&D and deployment activities fit in the context of a wider life-cycle based approach. For master planning purposes, a standard decomposition of the ATM lifecycle has been adopted. Road maps show the R&D and deployment activities as foreseen in the current version of the plan:

- How and by when the ATM Service Level of the European ATM system needs to be enhanced to respond to evolving performance needs while transitioning to the ATM Target Concept. This is presented in the Operational Evolution Roadmaps showing per Service Level the changes for each line of change.
- The deployment plan for the evolution towards System Wide Information Management (SWIM).
- What and by when Stakeholders have to deploy to realise a Capability Level enabling a Service Level. This is presented in the Stakeholder Deployment Plans, which also include the lifecycle for R&D, and deployment.
- Which and by when supporting and enabling improvements need to be implemented.

## Benefits and Financing

The total investment for the implementation of the 2020 ATM System covering all stakeholder groups amounts to approx. €30Bn.

The Cost Benefit Analysis results are based on the following important assumptions; timely and synchronised implementation of the complementary and efficient ground ATM services and tools exploiting the airborne investments; and that ANS Providers/Airport Operators deliver the projected Quality of Service and unit cost reductions. For scheduled airlines the CBA is positive although for the service level 3 deployment phase the initial investment is high and the payback period is long.

With the current avionics cost estimates, analyses so far indicate that CBAs for BA & GA will likely be negative. Further work is required, especially to define suitable and more affordable enablers tailored to the BA and GA needs.
For the Military, the CBA computations started during SESAR Definition Phase have to be pursued with a better estimation of their benefits in their role as User, ANS provider and Airport operator.

Improved staff productivity remains the main driver to achieve reduction of ANS provision unit cost. This is achieved by introducing operational improvements to increase the ATCO productivity. This will allow to depart from the traditional way of adding sectors and associated staff when traffic increases. The investments to improve the performance of the system are mainly for the provision of better information to the controller and the introduction of advanced automation tools.

Additional initiatives, external to the scope of the SESAR Programme but within the framework of the Single European Sky, would have to deliver a unit cost reduction of €230/flight in order to achieve the Cost Effectiveness target of €400/flight. These initiatives will benefit from the technical ability of the ATM Target Concept to support FAB implementation and technical de-fragmentation. In addition, the exploitation of synergies between ANS Providers and the co-ordination of initiatives at European level (e.g. elimination of redundant CNS aids, generic validations) are facilitated as well. However, the potential effects of these initiatives have not been assessed by the SESAR Consortium since they are outside the scope of SESAR.

An economic scheme needs to be established which addresses the relationship between the required investments for all stakeholders and the commitment to achieve cost-effectiveness and quality of service targets from ANS Providers and Airport Operators. The collaboration in synchronous investment planning and measurement / evaluation of costs and benefits is therefore essential.

## Risks

The following high priority risks have been identified for the future of the Master Plan and therefore the SESAR programme as a whole:

- Non homogeneous deployment across Europe of ATM Service Level 0 and 1 initiatives;
- Governance Structure is not capable of ensuring successful deployment of ATM Service Levels 2 to 5;
- Future investment in SESAR by key Stakeholders will not be secured;
- Future work on the ATM Target Concept exposes shortcomings in meeting design and performance targets;
- Delays to the availability of new technologies to support the ATM Target Concept;
- SWIM is not implemented in its correct form or sufficiently early.
- Regulatory Framework is unable to support the implementation of the ATM Target Concept;
- Performance based approach not implemented;
- Failure to manage human resources, human performance, social factors and change management;
- No agreement on future de-fragmentation of European airspace.

## SESAR is ready for the Development Phase and implementation

The Master Plan will guide the future of ATM in Europe over the next decades and forms the basis for the programme of work for the first part of the SESAR implementation phase. It will become a “rolling” plan that will be regularly updated in accordance with the results from the R&D activities starting under the responsibility of the SESAR JU. Continuous performance monitoring will need to be undertaken to ensure that the future ATM activities will be conducted to deliver the agreed benefits defined within an agreed performance framework. All major stakeholders in Europe have come together to agree upon this rational step forward to achieve the performance driven ATM system in Europe.

This Master Plan will be handed over to the SESAR JU, which is responsible for its execution and updates for the coming years. At this stage all stakeholders in Europe are asked to adopt this Master Plan including their commitment to the implementation of IP1 and to the R&D plan in support of IP2 and IP3. All stakeholders will be requested to analyse the Master Plan in respect of their country/organisations criticality and implement the actions in the timeframe required.

The focus for all stakeholders should be (1) on timely deployment of the short-term solutions bringing early benefits, and (2) on the R&D activities of the SESAR JU that shall allow for (a) timely deployment of the 2020 System and (b) consolidation of the final roadmap for the implementation of the ATM Target Concept.

Proactive management and anticipation of the future will support the successful implementation, which at one point will be supported by economic regulation. Political support is needed not only for SESAR but also regarding further cooperation, alliances or mergers of Air Navigation Service provision by the FAB initiative, together with additional measures envisaged by SES Package II. Further work is urgently required to reach the cost-effectiveness target.

**The SESAR Consortium, and associated partners have agreed on the SESAR Master Plan (D5) representing the fundamental coordination tool for all future ATM activities.** The Implementation of the Master Plan together with the SESII package will lead to a better performing ATM system in Europe.

## Key requirements for the SESAR future

The objective of the Master Plan is to meet the performance targets and to deliver the expected benefits to the ATM stakeholders. The following seven key requirements have been identified as critical for the successful implementation of the Master Plan:

1. Establishing **a single European Legislative Framework:** The rationalisation and alignment of European and national regulations is essential for the full implementation of the Single European Sky. However, regulation should only be used where necessary in accordance with "better regulation" principles to reach agreements and to support enforcement of commitments across the diversity of Member States and stakeholder interests;

2. A **performance-driven approach:** The SESAR performance framework builds on ICAO guidance material and existing processes to develop a European-wide system for setting, agreeing, and maintaining performance targets. This needs to be established within the regulatory framework as anticipated by the European Commission to reach the required improvements in safety, efficiency, capacity, environmental sustainability and cost-effectiveness. The whole approach needs to be supported by a comprehensive monitoring and reporting system;

3. Clear **ownership and endorsement of the Master Plan** at all levels, political, regulatory, and industry. In consequence, this will require transparency and alignment of the operating and investment plans of all stakeholders, in particular, NSAs, ANS Providers, airspace users (including the military), airports and third party suppliers (supply industry, aircraft manufacturers, etc.);

4. Definition of **clear governance and leadership structure for the deployment** activities covering all phases is vital.
   This coordination should be realised (a) through the implementation of the deployment programmes, which need to be agreed, (b) through strengthening stakeholder engagement and influence in appropriate forums, e.g. a future ATM Performance Partnership as part of the business framework and specifically for Implementation Package 1 (c) through the re-enforcement of a renewed ECIP/LCIP process to cover the SES monitoring requirements;

5. The establishment of a **single system design function:** Having established an European ATM Enterprise Architecture to facilitate the ATM performance partnership, a single system design function needs to be formed as referenced in SESAR Deliverable D1 for the design of the technical architecture of the future ATM System;

6. To ensure **interoperability of SESAR results** at regional and global level, it is necessary to link the system design activities with the existing standardisation processes (EUROCAE, RTCA, etc.) including the military and the respective regulatory structures (SES, ICAO, etc.);

7. Industry must be able to **balance cost and benefits.** The long lead times in some areas of the Master Plan may need measures to guarantee proper funding, where necessary through incentives, to keep to the schedule for investing in the deployment of the SESAR target solutions and decommissioning legacy systems.

# 1 Introduction

## 1.1 Purpose and Scope

### 1.1.1 D5 and the Master Plan

D5 represents the High Level Overview of the SESAR Master Plan (further referred to as the Master Plan). It is the agreed strategic guideline delivered by the SESAR Consortium. It identifies necessary activities on a Stakeholder Group level.
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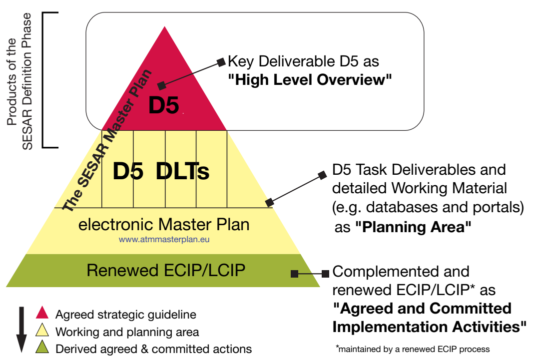



Figure 3: Structure of the Master Plan

All three elements of the Master Plan, the "High Level View" (D5), the "Planning Area" and the "Agreed and Committed Implementation Activities" (renewed ECIP/LCIP process) provide the necessary set of planning means to ensure the successful implementation of the SESAR ATM Target Concept.
The Master Plan will become a "rolling" plan that will be regularly updated, while continuous performance monitoring will be undertaken to ensure that the future ATM activities will deliver the agreed benefits defined within an agreed performance framework. This Master Plan will be handed over to the SESAR JU who is responsible for its execution and updates for the coming years.

### 1.1.2 Relationship with D4

D5 has built on the previous SESAR deliverables, in particular D4, which has described how the Deployment Sequence would realise the ATM Target Concept [Ref. 4]. A summary of the results and findings of the previous SESAR Milestone Deliverables D1-D4 can be found in Annex 9.1.
D5 has further refined the D4 deployment sequence by splitting each of the three Implementation Packages (IP) into two ATM Capability Levels (ACL) with associated ATM Service Levels (ASL). This extra granularity was needed to slice the deployment sequence into smaller chunks, which better match the needs of the "rolling" Master Plan update process.
D5 turns the D4 deployment sequence into the Master Plan by proposing an initial set of dates for the lifecycle timing of all development activities that precede the operational introduction of the system enhancements and operational improvements foreseen in the deployment roadmaps. In particular, this Master Plan defines for each topic: when R&D should start, by which target date it has to be completed, and following this how much time is foreseen for initial implementation, in order to achieve agreed target dates for Initial Operational Capability (IOC) in Europe. These IOC dates have been chosen in D4 with the objective of striking a balance between, on one hand, the future performance needs of the most challenging operational environments in Europe, and on the other hand the complexity and present maturity of the individual topics which will be subject to R&D and implementation. The information used to establish these critical dates (e.g. for R&D, IOC, etc.) is based on expert judgement.

### 1.1.3 Relationship with ICAO Planning Documents

This Master Plan document considers the Global Air Navigation Plan for Communication Navigation Surveillance/Air Traffic Management (CNS/ATM) Systems (Global Plan, Doc 9750), which was developed by ICAO as a strategic document to provide reference for the implementation of CNS/ATM systems.
The Global Plan supports global Interoperability and contains near and medium term guidance on air navigation system improvements necessary to support a uniform transition to the ATM system envisioned in the Global ATM Operational Concept (Doc 9854).
In accordance with the Global Plan, planning should be focused on specific performance objectives, supported by a set of "Global Plan Initiatives". These initiatives are options for air navigation system improvements that when implemented, result in direct performance enhancements. States and regions will choose initiatives that meet performance objectives, identified through an analytical process, specific to the particular needs of a State, region, homogeneous ATM area or major traffic flow. The terminology and methodology used in this document are consistent with ICAO use.

## 1.2 Document organisation

This document is organised as follows:
Chapter 1 provides a brief introduction to the purpose and scope of the D5 document.
Chapters 2 to 5 contain planning information (including benefit, financing and risk aspects), which is essentially time-based. This is schematically illustrated in Figure 4.

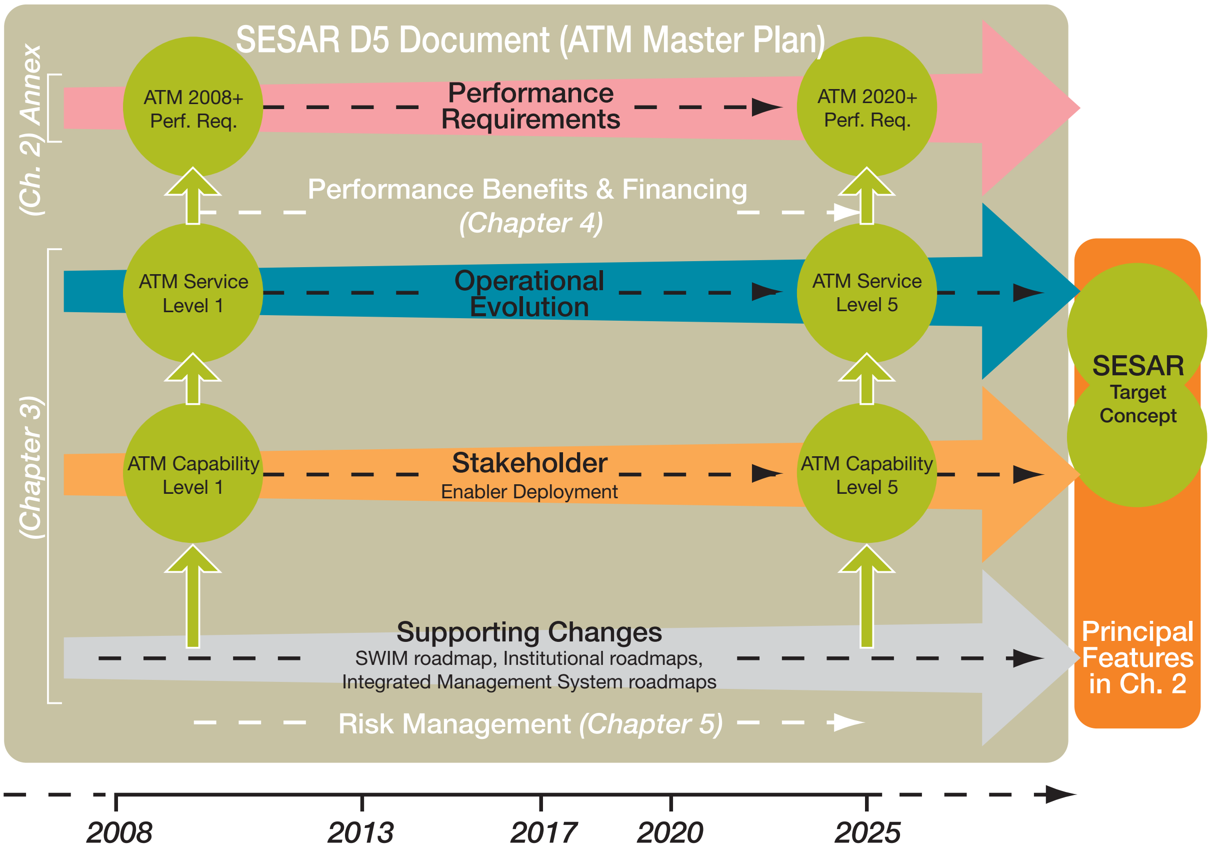


Figure 4: Contents of the D5 Document

**Chapter 2** describes the principles used to build the Master Plan and introduces the way in which it should be managed in the future.
**Chapter 3** contains the heart of the Plan. It contains three sections: (1) the roadmaps for operational evolutions, (2) supporting changes like the evolution towards System Wide Information Management (SWIM), the institutional roadmaps, and the Integrated Management System roadmaps; and (3) the stakeholder deployment plans for ATM systems and infrastructures. For each of these it identifies in detail the deployment actions which must be taken to implement the ATM Target Concept, combining these with the detailed planning of the research and development work, which is needed to consolidate them.
**Chapter 4** describes the benefits, the investments and the financial aspects associated to the Master Plan for the implementation of the ATM Target Concept. An evolutionary approach to meeting the performance targets and optimising the benefits has been taken in order to secure the financial viability of the Plan. Whilst the focus of the benefits planning to 2020 has been in the KPAs of cost effectiveness and capacity, including the quality of services, benefits are anticipated in all KPAs.
**Chapter 5** provides an outline of the high priority risks and associated mitigation actions for the implementation the Master Plan. The material contained in this Chapter has been analysed and built upon the major solution risks, which were identified and tracked throughout the production of the SESAR Deliverables D1 to D4. They should be the basis of the programme of work to be defined in the SESAR Deliverable D6 and undertaken by the SESAR JU. They are considered to be the high risk aspects of achieving the Master Plan and hence, those aspects which should be worked on, as a matter of urgency, from the very start of the SESAR Development Phase.

# 2 Building the Master Plan

This chapter describes the principles used to build the Master Plan and introduces the way in which it should be managed in the future.

## 2.1 Performance-Based Approach

ICAO defines the Performance Based Approach [Ref 14] as being based on the following three principles:

- **Strong focus on desired/required results;**
- **Informed decision making, driven by the desired/ required results;**
- **Reliance on facts and data for decision-making.**

The initial activities to make the transition have been carried out. D2 set performance expectations which the ATM industry should deliver and established a SESAR performance framework based upon the 11 ICAO KPAs, setting performance objectives for each of them, with associated indicators and targets. In response to the performance objectives and targets, D3 has defined the Target Concept and D4 has outlined the overall deployment sequence for implementing it; the sequence being expressed in terms of operational improvement (OI) steps and associated enablers.

### 2.1.1 Performance Framework

In November 2005, during the public announcement of the SESAR Definition Phase contract, EC Vice-President Jacques Barrot expressed the EC objectives of the SESAR programme, which are to achieve a future European Air Traffic Management (ATM) System for 2020 and beyond which can, relative to today's performance:

- **Enable** a 3-fold increase in capacity which will also reduce delays, both on the ground and in the air;
- **Improve** the safety performance by a factor of 10;
- **Enable** a 10% reduction in the effects flights have on the environment and;
- **Provide** ATM services at a cost to the airspace users which is at least 50% less.

These statements constitute the political vision and goals for the design of the future ATM System. These vision and goals have been analysed by reference to the 2020 demand and has resulted into specific initial targets for that particular year, notwithstanding the subsequent evolutions necessary to meet the growing demand.

This performance framework has been clarified and refined as a result of D3 and D4 activities. It shall be noted that the ATM System will further evolve after 2020 in order to sufficiently address the political design goals. D2 has to be read in conjunction with the material contained in the SESAR Definition Phase report “Performance Objectives and Targets” [Ref 13]. The SESAR Performance Framework is summarised in Annex 9.4, with an overview of the Key Performance Indicators (KPI) for which targets have been agreed as described in Table 1 below.

| KPA | Key Performance Indicator (KPI) | Baseline | | 2020 Target | |
|---|---|---|---|---|---|
| | | Year | Value | Absolute | Relative |
| Capacity | Annual IFR flights in Europe | 2005 | 9.2 M | 16 M | + 73% |
| | Daily IFR flights in Europe | 2005 | 29,000 | 50,000 | + 73% |
| | Best In Class (BIC) declared airport capacity in VMC (1 RWY), mov/hr | 2008 | 50 | 60 | +20% |
| | BIC declared airport capacity in VMC (2 parallel dependent RWYs), mov/hr | 2008 | 90 | 90 | +0% |
| | BIC declared airport capacity in VMC (2 parallel independent RWYs), mov/hr | 2008 | 90 | 120 | +25% |
| | BIC declared airport capacity in IMC (1 RWY), mov/hr | 2008 | 25 | 48 | +90% |
| | BIC declared airport capacity in IMC (2 parallel dependent RWYs), mov/hr | 2008 | 45 | 72 | +60% |
| | BIC declared airport capacity in IMC (2 parallel independent RWYs), mov/hr | 2008 | 45 | 96 | +110% |
| Cost Effectiveness | Total annual en-route and terminal ANS cost in Europe, €/flight | 2004 | 800 | 400 | -50% |
| Efficiency | Scheduled flights departing on time (as planned) | | | >98% | |
| | Avg delay of the remaining scheduled flights | | | <10 min | |
| | Flights with block-to-block time as planned | | | >95% | |
| | Avg. block-to-block time extension of the remaining flights | | | <10 min | |
| | Flights with fuel consumption as planned | | | >95% | |
| | Avg. additional fuel consumption of the remaining flights | | | <5% | |
| Flexibility | Accommodation of VFR-IFR change requests | | | >98% | |
| | Unscheduled flights departing on time (as requested) | | | >98% | |
| | Avg delay of the remaining unscheduled flights | | | <5 min | |
| | Scheduled flights with departure time as requested (after change request) | | | >98% | |
| | Avg delay of the remaining scheduled flights | | | <5 min | |
| Predictability | Coefficient of variation for actual block-to-block times: for repeatedly flown routes | | | <1.5% | |
| | Flights arriving on time (as planned) | | | >95% | |
| | Avg arrival delay of the remaining flights | | | <10 min | |
| | Total reactionary delay | 2010 | | | -50% |
| | Reactionary flight cancellation rate | 2010 | | | -50% |
| | Total service disruption delay | 2010 | | | -50% |
| | Percentage of diversions caused by service disruption | 2010 | | | -50% |
| Safety | Annual European-wide absolute number of ATM induced accidents and serious or risk bearing incidents | 2005 | | No increase | |
| | Safety level (per flight) | 2005 | | | x 3 |
| Environmental Sustainability | Avg. fuel savings per flight as a result of ATM improvements | 2005 | | | 10% |
| | Avg. $CO_2$ emission per flight as a result of ATM improvements | 2005 | | | -10% |
| | Compliance with local environmental rules | | | 100% | |
| | Number of proposed environmentally related ATM constraints subjected to a transparent assessment with an environment and socio-economic scope | | | 100% | |

Table 1: Summary of the 2020 Performance Targets

D2 concluded with the following particular recommendations:

- Distinct business & regulatory management frameworks be created which work to a common performance framework based upon that developed by ICAO (International Civil Aviation Organisation), and which have a "dynamic working relationship" between them to ensure the best outcome is achieved for the ATM industry as a whole;
- The ICAO global ATM operational concept [Ref 5] be used as the reference for the development of the ATM system;
- Stakeholders have to establish an ATM Performance Partnership (ATMPP).

### 2.1.2 Concept of Operations

Using D1 and D2 as the basis, the Concept of Operations was developed in D3. Its principle features are:

- Trajectory Management that is introducing a new approach to airspace design and management;
- Collaborative planning continuously reflected in the Network Operations Plan (NOP);
- Integrated Airport operations contributing to capacity gains;
- New separation modes to allow for increased safety, capacity, and efficiency;
- An increased reliance of airborne and ground based automated support tools;
- System Wide Information Management (SWIM) integrating and properly disseminating all ATM business related data;
- Humans who will be central in the future European ATM system while their role is evolving to managing and decision-making.

More detailed information is available in [Ref 17].

## 2.2 ATM Performance Partnership

To support the ATM management process, D2 has identified the need for Business Management & Regulatory Management frameworks which both work to a common performance framework (see section 2.1.1).

The Business Management framework should be established by an ATM Performance Partnership, this being composed of the: i.e. Civil Airspace Users (both Commercial and Non-Commercial), Military, ANS Providers, Airports, Supply Industry (for their design part), EUROCONTROL (for their pan-European and regional functions) and Social Partners. In order to:

- Reconcile the different partners' business and/or mission objectives;
- Identify those aspects of their visions which are common in terms of creating and managing the future ATM System;
- Defining how the partners should interact to create and manage the future System.

This yet-to-be established ATM Performance Partnership is intended to be based on the principles of a European ATM Enterprise Architecture (EAEA).

### 2.2.1 European ATM Enterprise Architecture

European ATM should be considered as a virtual single enterprise in which the constituent parts work together in a networked (net-centric), service-based operation with the business processes driving the services (including IT). The concept of this virtual single enterprise is instantiated in the European ATM Enterprise Architecture (EAEA).

It encompasses the structure and behaviour of the virtual single enterprise's ATM related processes, functions, information systems, personnel and organizational sub-units aligned with the performance partnership's goals and strategic direction as defined by the Master Plan.

Having established an European ATM Enterprise Architecture to facilitate the ATM performance partnership, a single system design function needs to be formed as referenced in SESAR Deliverable D1 for the design of the technical architecture of the future ATM System. The role of this function is to be accountable for the System's overall design, in particular defining the high level ATM System requirements needed to meet future business needs and ensuring the coherent integration of air and ground systems throughout the whole System. The initial design of the ATM System and its subsequent changes are approved through the decision making process. This system design function supports this process by providing design knowledge and expertise to ensure the full scope of the changes to be made have been identified and providing assurance that the System will perform as required.

### 2.2.2 Service-Oriented Approach

To populate the EAEA, a Service-Oriented approach should be taken, it being the key enabler to allow aspects of the future ATM System to respond more quickly to rapidly changing business needs. Clearly, these need to be brought together in a coherent and consistent manner.

Here, in general, a service is defined as "the delivery of a capability in line with published characteristics (including policies)". The EAEA must clearly distinguish the ATM Services (also called Business services) that have to be provided from the underlying (technical) supporting services and the physical assets that will need to be deployed (also called Information Technology Services).

## 2.3 Structuring and Managing the Master Plan

### 2.3.1 ATM Service and Capability Levels

#### 2.3.1.1 Principles

The notion of ATM Service Level and ATM Capability Level will be used as the top-level, System-wide basis to establish the performance characteristics with which all components (covering both those on-board aircraft and within the ground-based systems) of the future European ATM System will be linked.
SESAR has defined six levels, which will progressively be deployed as shown in Figure 5.
**Capability levels** are associated with Stakeholder **systems, procedures, human resources etc.** Upgrading a Stakeholder to a higher capability level means deployment of new enablers, and this requires investments (costs).
**Service levels** are associated with operational **services** offered by a service provider and consumed by a service user. Upgrading a service to a higher service level means deployment of operational improvement steps, and this leads to benefits (performance improvements).

Delivering a service at a given service level X requires that *both* the service provider and the service user have *at least* evolved to capability level X[2] . Backward compatibility is also required: each system, which has a given capability level, should also be able to provide and receive services at a lower service level[3]. This ensures interoperability between systems of different capability levels. For example:

- Aircraft at capability level 3 is flying into a capability level 2 airport. They will provide and use service level 2. The performance benefits are those associated with service level 2.
- Aircraft at capability level 1 is flying into a capability level 2 airport. They will provide and use service level 1. The performance benefits are those associated with service level 1.

Utilising a service requires that both the service provider and the service user possess the required capability, but not necessarily all the capabilities of a particular level.
In a mixed ATM environment it is clear that such capability mismatches will occur to some extent. However the general rule for deployment should be that air and ground deployment should be geographically synchronised as much as possible, to avoid 'wasting' capabilities.
The above relationships are illustrated in Figure 6.

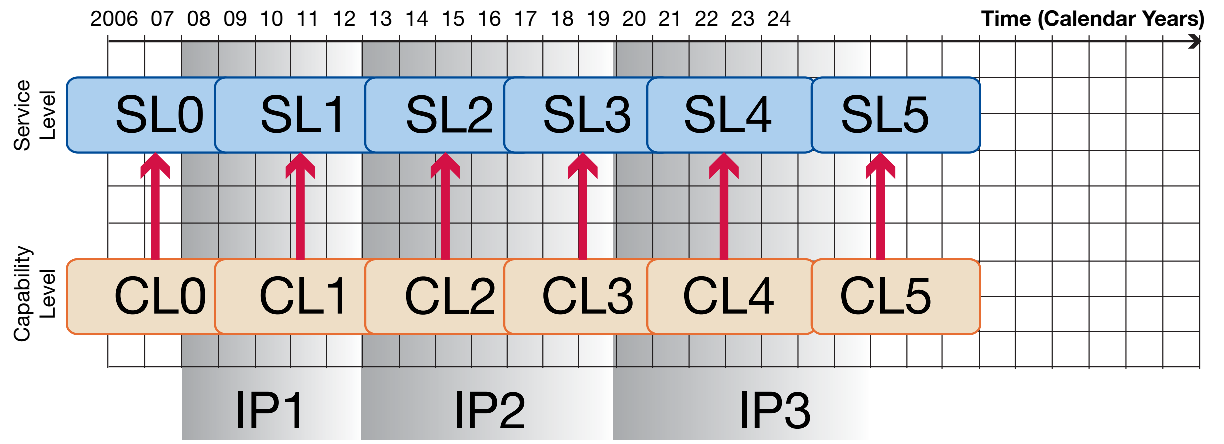



Figure 5: Deployment of ATM Service and Capability Levels

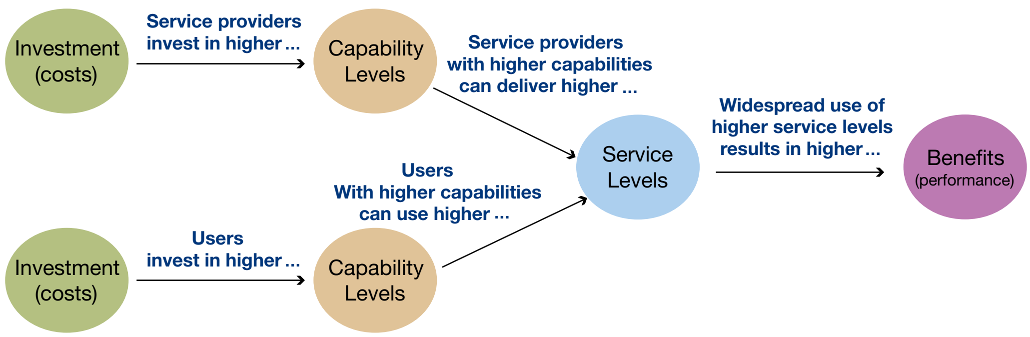



Figure 6: Relationship between ATM Service and Capability Levels

[2] The SWIM network will enable services to be provided using information from a variety of sources, for example, the flight operations centre is capable of providing trajectory data broadly equivalent to that obtained directly from an aircraft.
[3] Currently this capability does not exist; the service level is often only increased when compatible with the overwhelming majority of the traffic; to enable such a capability, the principles of Conops Section F1.1.1 [Ref 17] will need to be applied.

The notion of ATM Capability Levels had already been introduced in D3. Please note that the definition of some levels has been changed in D5:

- D5 Capability Level 3 did not exist in D3;
- D5 Capability Level 4 corresponds to D3 Capability Level 3;
- D5 Capability Level 5 corresponds to D3 Capability Level 4.

#### 2.3.1.2 Role of ATM Service and Capability Levels in the Transition Scenario

The above principles will come to life as described in the following performance based transition scenario, which is also illustrated in Figure 7.

- **R&D and Industrialisation of Enablers.** The execution of the Master Plan will lead to timely availability of more advanced ATM systems, procedures, human resource enablers, standards, and supporting regulatory and legislative changes (collectively called enablers). For the sake of consistent and synchronised strategic planning, these have been grouped into ATM Capability Levels. Between today and 2020, Research, Development and Industrialisation is planned for rolling out Capability Levels 1 through 3, followed by the roll-out of levels 4 and 5 from 2020 onwards. The Master Plan also includes a Level 0, which corresponds to currently available systems and best practices for which deployment is already in progress, but not yet completed;

- **Deployment of Enablers.** As part of the Stakeholder Deployment Plan, aircraft, airports, and ATM facilities serving TMAs and en-route airspace will be progressively equipped by the Stakeholders with these new capabilities where needed. The number of less capable units will diminish over time due to the need to accommodate the increase in traffic over the whole network, but at any given moment, the European ATM System will comprise aircraft, airports and ATM facilities of a variety of ATM Capability Levels;

- **Introduction of new operational improvements.** Each new ATM Capability Level will introduce enablers designed to support operational improvements corresponding to a certain ATM Service Level;

- **Synchronised deployment of Enablers.** Generally speaking, in order to receive services at a given ATM Service Level, the aircraft as well as the Service Providers responsible for the area in which they are operating (airports, TMAs, Enroute airspace) must be at least equipped to the corresponding ATM Capability Level (Figure 7);

- **Benefits dependent on speed of deployment in a mixed environment.** More advanced ATM Service Levels are associated with higher performance and deliver more benefits. As shown in Figure 7, at any one time, traffic composed of aircraft with different levels of ATM capability will be operating at a variety of ATM Service Levels in the European ATM System. It is important to ensure timely managed and efficient transition to the higher ATM Service Levels, and reduce the use of less advanced levels, because the greater the number of flights operating at the higher service levels, the greater will be the performance benefits overall. It should be noted that this regime provides a basis upon which to build financial incentives to promote the timely managed and efficient transition to higher service levels through, for example, differential pricing for different ATM Service Levels. In other cases a mandate will be necessary to achieve the required speed of transition;

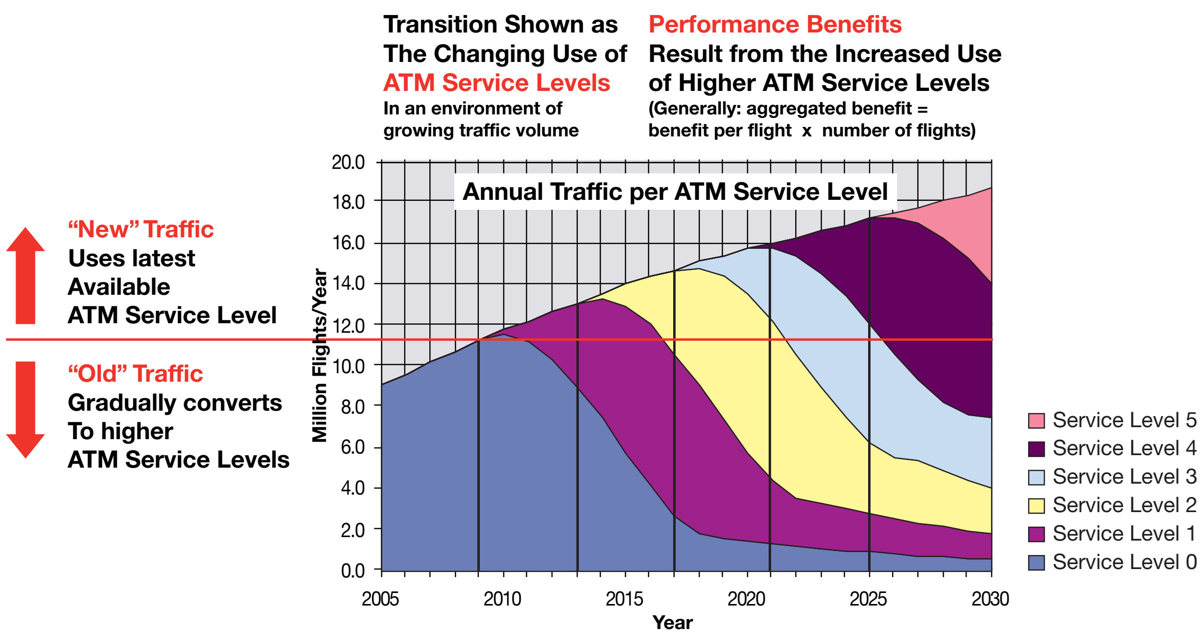



Figure 7: Principles for Performance Based Transition

- **Transition strategy of individual Stakeholders.** As traffic demand grows, the plan is to ensure that "new" traffic makes use of the most advanced ATM Service Level, which is available at that moment. In addition, "old" traffic will also progressively migrate to more advanced Service Levels, albeit with some years delay. This will be the result of retrofitting/upgrading aircraft, flight operation centres, airports and ATM facilities with higher ATM Capability Levels. This does however not mean or require that every unit will upgrade level by level. In a number of cases, (USER/ANS Provider/Airport Operators) stakeholders may wish to keep the number of retrofits to a minimum and decide to skip a level (e.g. to migrate from level 1 immediately to level 3).

#### 2.3.1.3 Relationship with Implementation Packages

For the sake of situating the various ATM Service and ATM Capability Levels in time, the SESAR Implementation Phase has been subdivided into three time periods (called Implementation Packages in D4 [Ref 5]) which are linked to the Initial Operational Capability (IOC) dates of the ATM Service Levels as shown below and in Figure 5:

- IP1 – Implementation Package 1 (short-term: IOC dates up to 2012)
  - o Covers ATM Service Levels 0 and 1;
- IP2 – Implementation Package 2 (medium term: IOC dates in the period 2013-2019)
  - o Covers ATM Service Levels 2 and 3;
- IP3 – Implementation Package 3 (long term: IOC dates from 2020 onwards)
  - o Covers ATM Service Levels 4 and 5.

#### 2.3.1.4 Relationship with ECIP/LCIP

The current edition of ECIP/LCIP covers the period 2008-2012. It is clear from the above that its contents should correspond to the deployment of ATM Service and ATM Capability Levels 0 and 1.

### 2.3.2 ATM Lifecycle Approach

This section is a guide to understanding the road maps which are presented in Chapter 3.
Road maps show the R&D and Implementation activities as foreseen in the current version of the plan.
The activities planned for the 2008-2013 periods have been incorporated in the Work Programme that is presented in D6 [Ref 18].
The R&D and Implementation activities fit in the context of a wider *lifecycle* based approach.
For master planning purposes, a standard decomposition of the ATM lifecycle has been adopted. The complete lifecycle is subdivided into eight phases[4] as shown in Figure 8.

Each change to a Stakeholder system or an ATM service goes through a number of lifecycle phases, starting with R&D (comprises identification of needs, concept definition, feasibility studies and pre-industrial development and integration), implementation (comprises industrialisation and deployment), culminating with operational use, and ultimately ending with decommissioning. The execution of each phase corresponds to an activity and that activity comprises the production of business case, safety case and validation.

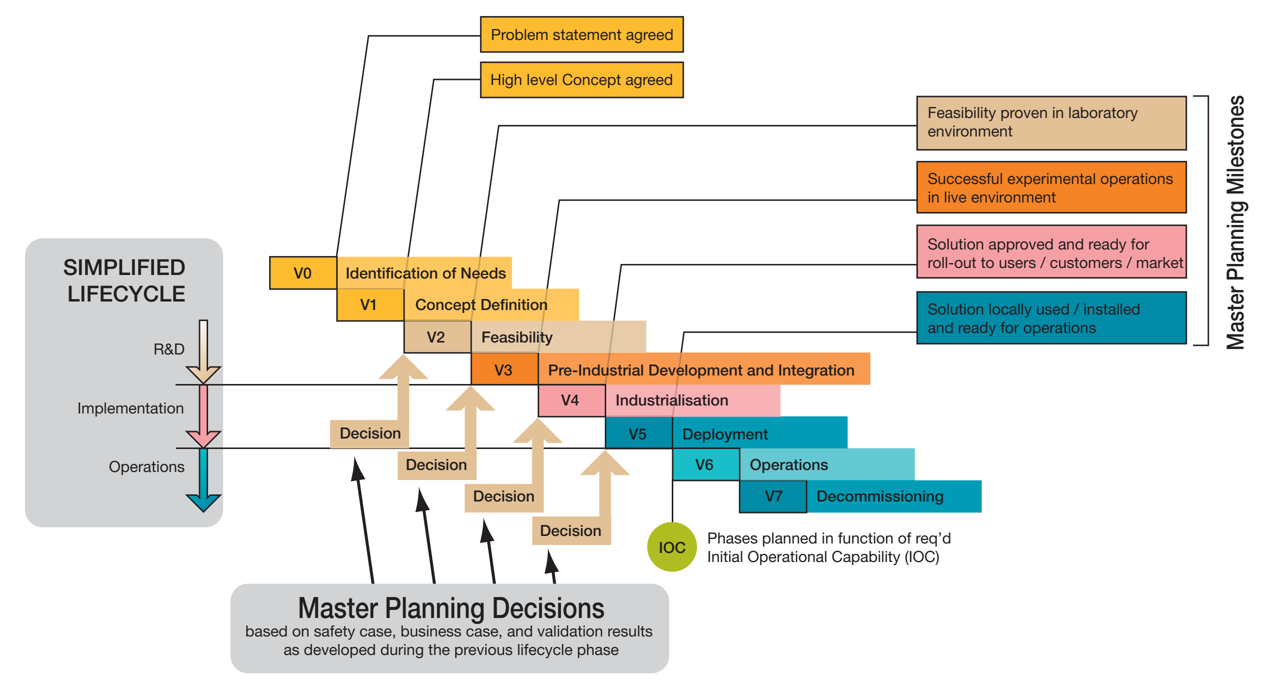



Figure 8: Master Planning Lifecycle Phases, Decisions and Milestones

[4] Phases 0 to 5 are based on the E-OCVM lifecycle phases.

For a correct interpretation of the meaning of each phase, please look at the expected milestone outcome (depicted in D6).

Not all phases are addressed in detail in the Master Plan. The roadmaps shown in Chapter 3 of the plan show only the "simplified lifecycle" as depicted on the left side of Figure 8.

An important milestone for Master Planning is the Initial Operational Capability (IOC) date. This corresponds to the first time an operational improvement is needed to start delivering benefits. For enablers the IOC date implies that a change has been deployed and is ready for operations. The enabler IOC dates are driven by the timing of the operational improvements they support. IOC dates are therefore central in the Master Planning process. All earlier lifecycle phase dates have been planned according to the target IOC dates. The point in time where full stakeholder deployment is made is called the Full Operational Capability (FOC) date.

At the level of Master Planning, the major decisions are about:

- Whether or not (and when) to start each lifecycle phase;
- What to do during each lifecycle phase (depends on synchronisation needs with other activities);
- Reaching agreement on the completion of each lifecycle phase, i.e. the achievement of milestones.

The decision to start a lifecycle phase implies a commitment from all involved stakeholders in terms of schedule, financing and contributed resources.

In the context of SESAR, the use of standard lifecycle phases for planning R&D and Implementation activities has the following advantages:

- Lifecycle phases provide a framework which clearly scopes the type of work that has to be performed in the Work Programme [Ref 18];
- Lifecycle phases are designed to support a progressive refinement, development and validation from the high level concept (as specified in D3) to real, wide-spread operational use of a change;
- Lifecycle phases are designed to manage the development risks (feasibility, time and expenditure): the Feasibility phase is relatively short and relatively low budget. It serves to ensure early reduction of uncertainty and allow timely re-orientation of the Master Plan (if necessary), prior to the more expensive and time-consuming pre-industrial development and integration. This in turn is used to mitigate Industrialisation risks, and so on. Re-orientation of the Master Plan implies adjustments, prioritisation or even cancellation of developments, possibly in other parts of the Master Plan. This re-orientation cross-check must ensure the consistency and synchronisation of the various parts of the plan;
- The above underlines the importance of lifecycle related decision-making: each boundary between two phases is a checkpoint and decision point in the development and deployment of an operational or technical change. After each completion of a lifecycle phase, its results must be checked and used to update and maintain the Master Plan information. Go/no-go decisions for follow-on activities should be based on the basis of the most up-to-date Master Plan information.

### 2.3.3 Pro-active Management of the Decision Calendar

At the highest level, the objective of Master Plan execution is to realise ATM performance improvements not just of the required *magnitude*, but also in a *timely* fashion, so as to meet the performance targets required/expected for a certain date.

Even if the target concept is capable of delivering improvements of the required magnitude, and that progress in delivering these improvements is indeed made, there is still a risk that the improvements are not delivered in a *timely* fashion, due to slow progress in Master Plan execution.

Slow progress can have several causes:

- Lifecycle phases taking longer than originally planned;
- Lifecycle phases starting later than planned, with delays due to:
  - o Lack of timely decision making;
  - o Lack of synchronisation between prerequisite activities.

The European and global institutional decision-making timescales, in the context of SESAR's implementation, introduce the potential for significant risk to the desired timescale, unless the sequence and timing of decision-making is carefully managed.

To mitigate the risk of delayed lifecycle phase start, SESAR [Ref 16] has identified the need for proper planning and management of decision-making. This is seen at two levels:

- At overall system level, via the approval and buy-in to periodic Master Plan updates. The associated decision making is part of the Master Plan Maintenance process;
- At the level of Decision Plans for the key elements within the Master Plan (i.e. the road maps depicted in Chapter 3).

As already mentioned in this section, IOC dates are central in the overall planning process. The declaration of IOC for an operational improvement or an enabler is a *major decision*. The date at which this decision is planned must be *realistic* (achievable), *coordinated* (to respect the logic of the deployment sequence and all dependencies) and also be *suitable* within the larger context of performance planning (i.e. to enable timely delivery of performance). The total collection of IOC dates for operational improvements and enablers can be considered the *IOC Plan*. As part of the Master Plan Maintenance process, the realism, coordination and suitability of these dates will have to be periodically revisited. IOC dates will need to be advanced or delayed when changing circumstances dictate so.

Surrounding the IOC Plan (and governed by it) are two decision plans which are different in nature but closely connected and jointly developed, covering the key elements within the Master Plan:

- *Pre-IOC Decision Plan:* this covers all decisions which have to be taken within the context of R&D, Industrialisation, standardisation, regulation/legislation, investment, establishment of incentives etc.;
- *Post-IOC Decision Plan:* this is part of the detailed Deployment Plan (planned and monitored through the renewed ECIP/LCIP mechanism) that describes who will deploy what, when and where. It covers all decisions which have to be taken by the Stakeholders to achieve synchronised (air/ground) deployment between IOC and FOC, in line with network-wide and local performance/business needs, incentives and all regulatory and legislative obligations.

This includes the financing and funding decisions and also any decommissioning decisions. The aim is to obtain commitment and achieve clear alignment of stakeholder plans with the Master Plan.

SESAR [Ref 16] has identified a number of reasons why decisions need to be planned ahead. The most significant ones are:

- Need for synchronisation of R&D activities: IOC dates of enablers are driven by the planned IOC dates of related operational improvements. This drives the calendar of events in the Pre-IOC Decision Plan;
- A lot of these events are decisions to be taken by external (institutional) decision-making bodies. The key decision points must be carefully planned and co-ordinated for specific meeting agendas between the different institutions as appropriate to ensure that they can be taken by the relevant deadline. In some cases this may require a Decision Plan extending up to 5 years ahead to ensure that the critical decision path is met on time;
- Often there is no time for activities to go round the institutional decision-making loop twice. Everything being presented for a formal decision must be accompanied by ALL the necessary justifications and supporting material.

The timing requirements, which follow from the above reasons, are illustrated in Figure 9. The figure illustrates the dependency of a target start date on a single decision, but in reality there will often be many prerequisite decisions, which must be coordinated to prevent undue delay of the target start date. This again underlines the need for careful decision planning, followed by active management of the decision calendar. It should also be noted that the required time horizon of the Decision Plan varies: for certain international decision meetings like the World Radio Conference the planning horizon needs to be several years; for other decision bodies which are meeting frequently a look ahead of one year will be more than sufficient. It is clear that there is no need to define all decisions right from the start.

The current version of the Master Plan (with its breakdown of activities into lifecycle phases and associated milestones and decision points) can be considered as an initial version of the Decision Plan. The current D5 information is not specific and detailed enough to make a meaningful assessment of what has to be decided by whom, using which consultation and decision making process. During the SESAR Development Phase, it will be the responsibility of the SESAR JU to progressively refine the Decision Plan on R&D matters based on more detailed analysis of the Master Plan with supplemental input from R&D results.

Risk management (Master Plan high priority risks are addressed in Chapter 5 of this document) has different decision-making needs. Risk mitigation actions are pre-planned responses to the potential occurrence of certain events. When a risk event occurs (or is about to occur), it is essential that the associated mitigation action can be launched without delay. Those responsible for the execution of the action must ensure rapid response decision-making.

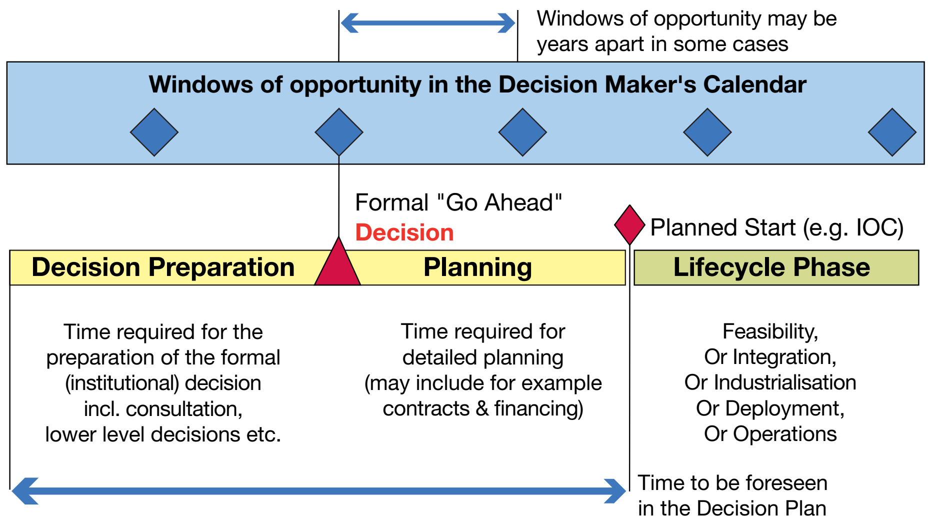



Figure 9: Timing Requirements in Decision Planning

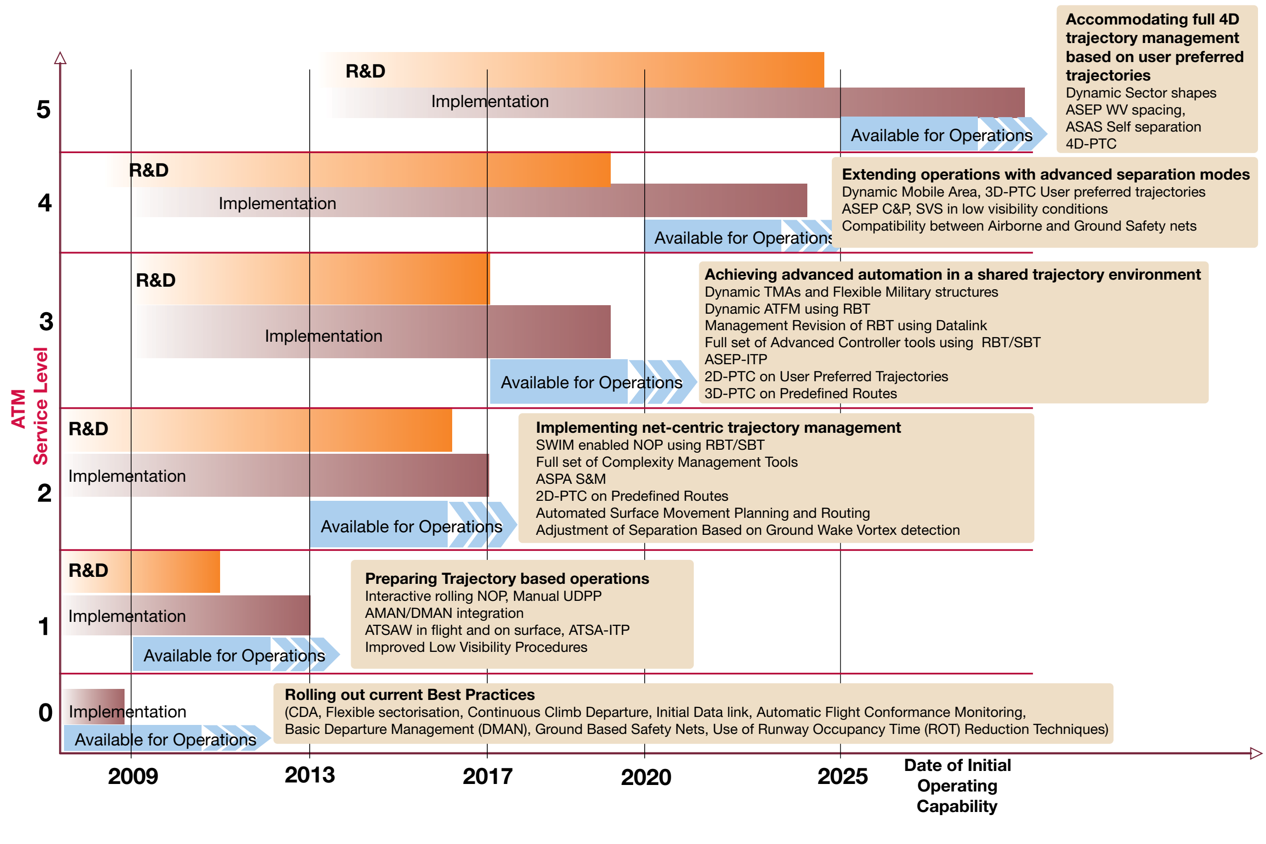
## 2.3.4 Master Plan Maintenance

The Master Plan will guide the future of ATM in Europe over the next decades and forms the basis for the programme of work for the first part of the SESAR implementation phase. It will become a "rolling" plan that will be regularly updated in accordance with the results from the R&D activities starting under the responsibility of the SESAR JU. Continuous performance monitoring will need to be undertaken to ensure that the future ATM activities will deliver the agreed benefits defined within an agreed performance framework. This Master Plan will be handed over to the SESAR JU that is responsible for its execution and updates for the coming years.

# 3 Plan for Implementing the ATM Target Concept

This chapter presents:

- How and by when the ATM Service Level of the European ATM system needs to be enhanced to respond to evolving performance needs in the scope of the ATM Target Concept. This is presented in the Operational Evolution Roadmaps showing per ATM Service Level the changes for each Line of Change (LoC)[5] of the ATM Target Concept;
- The deployment plan for the evolution towards System Wide Information Management (SWIM);
- The other enabling changes (standardisation, legislation, regulation and integrated management of environment, safety and security) to be implemented to support the European ATM system evolution;
- What and when should Stakeholders deploy processes and enablers to realise ATM Capability Level enabling expected ATM Service Level. This is presented in the Stakeholder Deployment Plans, which also include the lifecycle for R&D and Implementation.




Note: Long R&D and implementation durations are the result of combining many data but do not reflect the time needed to introduce a specific improvement at a specific location.

Figure 10: Master Plan Overview

[5] Lines of Change (LoC) represent the main operational areas that describe the evolution of the ATM environment.

Since **Safety** is a design driver, any Quality of Service increase shall not deteriorate the Safety level and any Capacity increase shall imply a proportionate increase in Safety. However, the Safety target would be met if in addition to the previous measures:

- At Airports (see LoC#10) specific initiatives like runway incursion are early deployed;
- New communication, navigation and surveillance technologies are being introduced providing better access to information and enabling the position of every aircraft (including GA) and vehicle to be electronically visible to other users of the system;
- Continuous improvement of Safety Net (see LoC#9) is implemented;
- Any Safety improvements are supported by an appropriate Safety Management Framework.

The performance based approach developed within SESAR Definition Phase came to the following conclusions: since any optimisation of the flight profile translates directly to an overall reduction of gaseous emissions, **any** Flight Efficiency improvement will have a positive impact on **Environment**. However, the Environment target would be met if in addition to the Flight Efficiency measures (see Flight Efficiency paragraph):

- At Airports (see LoC#10) specific initiatives such as expansion of best "practices" (e.g. reduction of taxi time) are being deployed;
- An Environmental Sustainability culture within ATM Governance is being developed.

The achievement of the **Capacity targets** will be supported by:

- In the short-term, the best use of existing capacity through a better planning process (see LoC#3 & LoC#4);
- In the mid-term, an increase of the ATCO Productivity through the use of New Separation Modes (see LoC#8), new controller support tools (see LoC#6, LoC#7) and a reduction of trajectory uncertainty (see LoC#5, LoC#1);
- At Airports (see LoC#10 ""), the rolling-out to best in class any runway utilisation improvements, taking into account the needed infrastructure enhancement.

The achievement of the **Efficiency targets** will be supported by:

- An increase of the Capacity level in order to reduce departure delay;
- The move from Airspace to Trajectory Based Operations (see Loc#2);
- In the longer run an increase of the benefit from the Trajectory Based Operations through the use of New Separation Modes (see LoC#8).

The achievement of the **Predictability targets** will be supported by:

- Any improvement in the planning process (see LoC#3) and queuing process (see LoC#7);
- Any improvement of operations under adverse conditions (see Loc#10).

The achievement of the **Flexibility targets** will be supported by:

- Any improvement in the planning process towards a more collaborative approach (see LoC#3).

Finally, the achievement of the **Cost Effectiveness target** will be supported by:

- An increase of the ATCO Productivity (see Airspace Capacity : LoC#5, 6 , 7 & 8);
- A cost effective approach when implementing any enablers related to an operational improvement.

The performance Objectives and Targets have been developed during SESAR Definition phase and captured in D2 [Ref 3]. This analysis has been used as the basis of the ATM Target Concept; it is of primary importance to consolidate the SESAR Performance Framework by developing targets for all 11 KPAs, assessing their trade-offs.

This chapter provides an overview of the Master Plan information implying that not all dependencies between Operational Improvement (OI) Steps and enablers can be shown. It shows graphical roadmap information at an aggregated level, i.e. per ATM Service Level (operational evolution, see section 3.1) or ATM Capability Level (stakeholder deployment plan, see section 3.3). In other words, each ATM Service Level groups a number of OI Steps and each ATM Capability Level a number of enablers. As a consequence, the steps of the lifecycle shown in each roadmap are overlapping.
Detailed Master Planning information is available at the level of individual OI steps in the DLTs [Ref. 6, 7 and 11] and in the electronic Master Plan (www.atmmasterplan.eu). This includes planned start and end dates of individual lifecycle phases. At this detailed level the lifecycle phases are sequential and non-overlapping.
As shown in Figure 11, links between the Stakeholder Deployment Plans and the Operational Evolutions roadmaps exist, and are inherited from the detailed traceability between enablers and OI steps included in the e-Master Plan. These links are outlined in the Stakeholder deployment plans that include, for each ATM Capability Level, a reference to the supported operational Line of Change (LoC).
Note: LoC#1 (Information Management) is not illustrated in the Operational Evolution roadmaps, as a specific section is totally dedicated to the description of the evolution towards SWIM, which is recognize as the common underlying principles of European ATM evolution.

The Integrated Management System roadmaps included in the Master Plan cover Safety, Security, Human Performance and Environment. These areas capture improvements (not directly of an operational nature) that contribute to the performance in one ore more KPAs. Other supporting subjects, not less important but with a supporting role to meet the R&D requirements/needs, are Validation Platforms R&D needed to make possible the validation activities required in the plan. The mentioned Validation Infrastructure needs are taken on board in the Work Plan (D6).
EAEA/SOA as a pre-requisite will, through the identification of each stakeholder strategic business objectives, lead to an efficient allocation of the business objective to each stakeholder systems. This will dictate how business services in support of the operational concept are realised both from a procedure and system point of view. Every system enabler roadmap is therefore impacted by this new framework.

The dates of the lifecycle phases have been determined on the basis of the planned IOC date (i.e. start of operation) and the estimated time required to complete the necessary preceding lifecycle phase activities. Figure 12 presents the legend applicable to all the roadmaps in the present chapter. It illustrates the use of the simplified lifecycle as presented in section 3.1. The IOC date for the respective activity (Service Level / Capability Level) has been used as the basis to determine the timeline for the implementation and R&D activities [Ref 8].

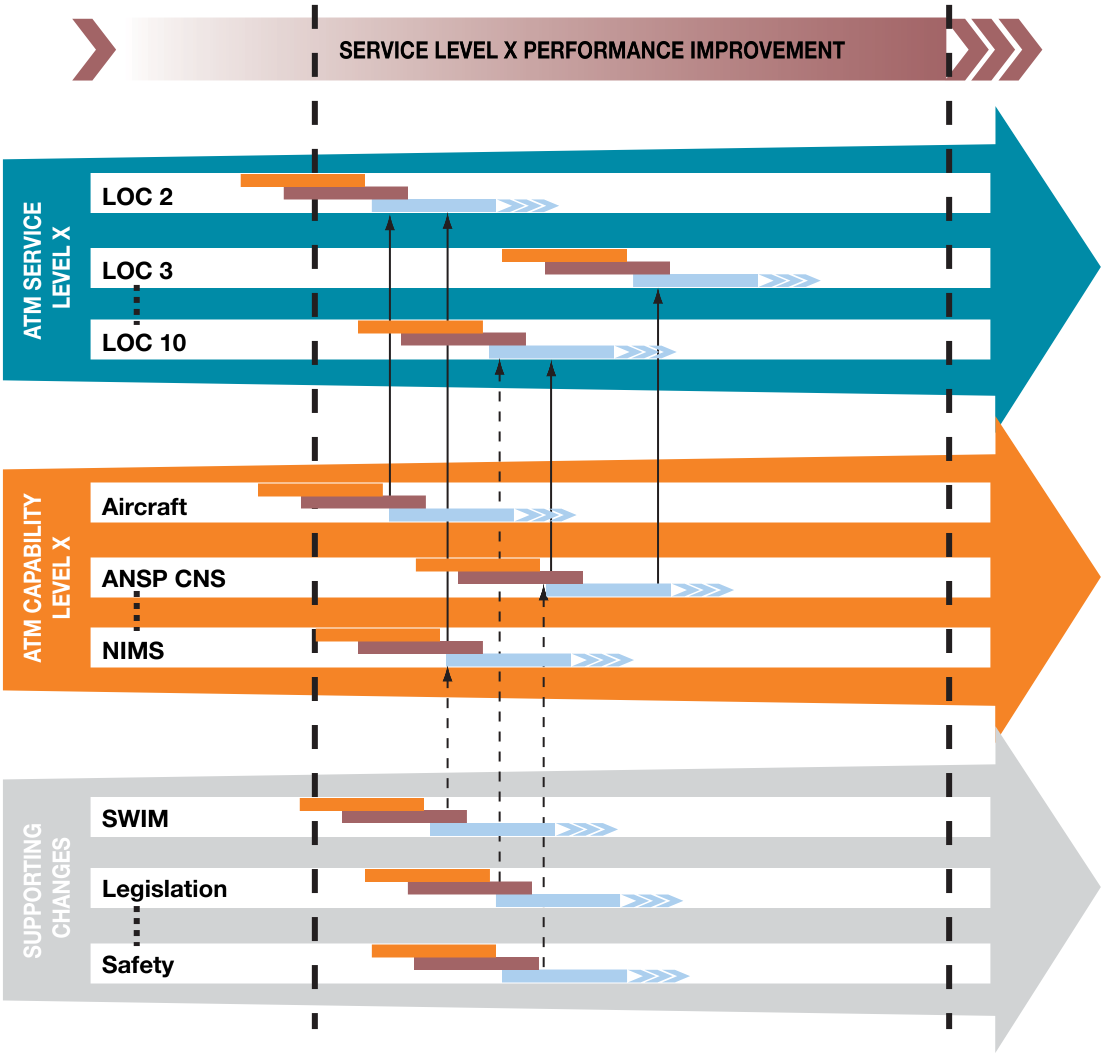



Figure 11: Links between the different types of roadmaps

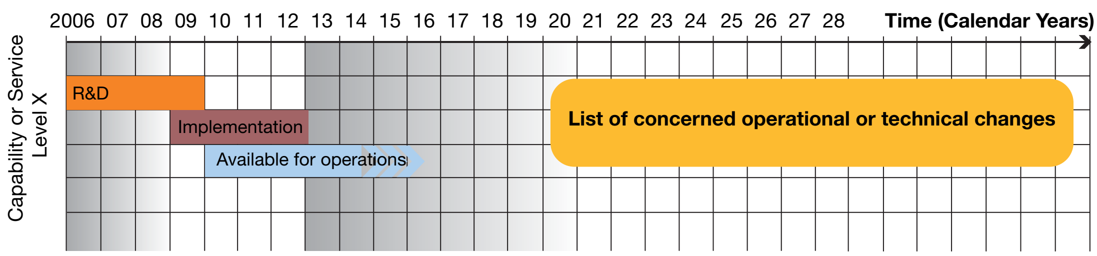



Figure 12: Roadmap legend

## 3.1 Operational Evolutions Roadmaps

Operational Evolutions are described for each of the ATM Service Level 0 to 5, covering the entire period from now till the full implementation of the ATM Target Concept [Ref 4].

Note: Following recent adoption, in February 2008, of the European Airspace Strategy [Ref 19], updates have been incorporated in the presentation of Line of Change 2 for the different ATM Service Level.

### 3.1.1 ATM Service Level 0

Service level 0 consists of rolling out current best practices and deploying available technologies, aiming at providing the processes and system support for efficient collaborative planning and timely decision making across the network. The on-going initiatives support the delivery of service level 0, ensuring that the improvements can be implemented in a short timeframe provided that the required level of stakeholder involvement is secured. These initiatives (e.g. DMEAN, LINK 2000+, etc) have been already highlighted in the previous deliverables.

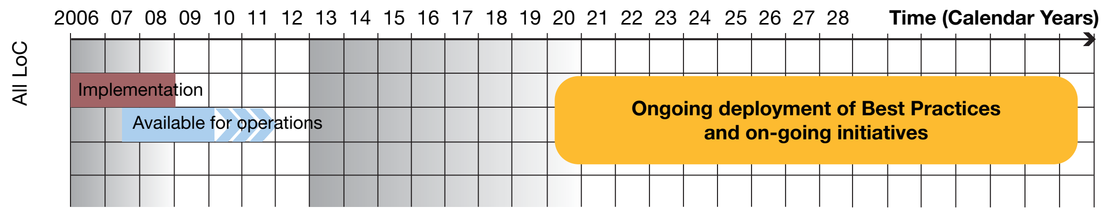



Figure 13: ATM Service Level 0

| LoC#2–Moving from airspace to trajectory based operations |
|---|
| **Ongoing deployment of Best Practices:** Multiple Route Options & Airspace Organisation Scenarios; Cross-Border Operations Facilitated through Collaborative Airspace Planning with Neighbours; Continuous Descent Approach (CDA); Flexible Sectorisation Management; Modular Sectorisation Adapted to Variations in Traffic Flows; Continuous Climb Departure; Terminal Airspace Organisation Adapted through Use of Best Practice, PRNAV and FUA Where Suitable; Moving Airspace Management Into Day of Operation; Harmonised EUROCONTROL ECAC Area Rules for OAT-IFR and GAT Interface; Modular Temporary Airspace Structures and Reserved Areas. |
| **LoC#3 - Collaborative Planning using the Network Operations Planner** |
| **Ongoing deployment of Best Practices:** Enhanced Seasonal NOP Elaboration; ATFM Slot Swapping; Interactive Network Capacity Planning; Enhanced Flight Plan Filing Facilitation. |
| **LoC#4 - Managing the ATM Network** |
| **Ongoing deployment of Best Practices:** Network Performance Assessment; ATFCM Scenarios; Management of Critical Events; Coordinated Network Management Operations Extended Within Day of Operation; Improved Operations at Airport in Adverse Conditions Using ATFCM Techniques. |
| **LoC#5 - Managing Business Trajectory[6] in real time** |
| **Ongoing deployment of Best Practices:** Automated Support for Traffic Load (Density) Management; Voice Controller-Pilot Communications (En-Route) Complemented by Datalink; Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue; Sector Team Operations Adapted to New Roles for Tactical and Planning Controllers. |
| **LoC#6 - Collaborative ground and airborne decision tools** |
| **Ongoing deployment of Best Practices:** Automated Assistance to ATC Planning for Preventing Conflicts in En-Route Airspace; Automated Flight Conformance Monitoring. |
| **LoC#7 - Queue Management Tools** |
| **Ongoing deployment of Best Practices:** Basic Departure Management (DMAN); Arrival Management Supporting TMA Improvements (incl. CDA, P-RNAV). |
| **LoC#9 – Independent Cooperative ground and airborne safety nets** |
| **Ongoing deployment of Best Practices:** Ground Based Safety Nets (TMA, En-Route). |
| **LoC#10 - Airport Throughput, Safety and Environment** |
| **Ongoing deployment of Best Practices:** Additional Rapid Exit Taxiways (RET) and Entries; Reduced Risk of Runway Incursions through Improved Procedures and Best Practices on the Ground; Improved Operations in Adverse Conditions through Airport Collaborative Decision Making; Improved Turn Around Process through Collaborative Decision Making; Collaborative Pre-departure Sequencing; Improved De-icing Operation through Collaborative Decision Making; Use of Runway Occupancy Time (ROT) Reduction Techniques; Interlaced Take-Off and Landing; Reduced Water Pollution; (Local) Monitoring of Environmental Performance; Enhanced Ground Controller Situational Awareness in all Weather Conditions; Guidance Assistance to Aircraft on the Airport Surface; Airport CDM extended to Regional Airports; Automated Alerting of Controller in Case of Runway Incursion or Intrusion into Restricted Areas; Reduced ILS Sensitive and Critical Areas; Brake to Vacate (BTV) Procedure; Aircraft noise mitigation at and around airports; Aircraft fuel use and emissions management at and around airports; Aircraft fuel use and emissions management in the en-route phase. |

6 For military operations the term "Business Trajectory" shall also be understood as "Mission Trajectory"

### 3.1.2 ATM Service Level 1

Service Level 1 aims to achieve the required interoperability between ATM partners to enable smooth migration to trajectory-based operations, taking initial benefit of "manual" User Driven Prioritisation Process (UDPP). The route network will be increasingly flexible to offer more options to airspace users. More advanced procedures and systems will be introduced to raise the safety and throughput of airports/sectors to the performance targets for the period. This will built upon conventional modes of separation while paving the way for new methods of control. Service Level 1 improvements will be carried out in compliance with the societal need for further environmental protection.

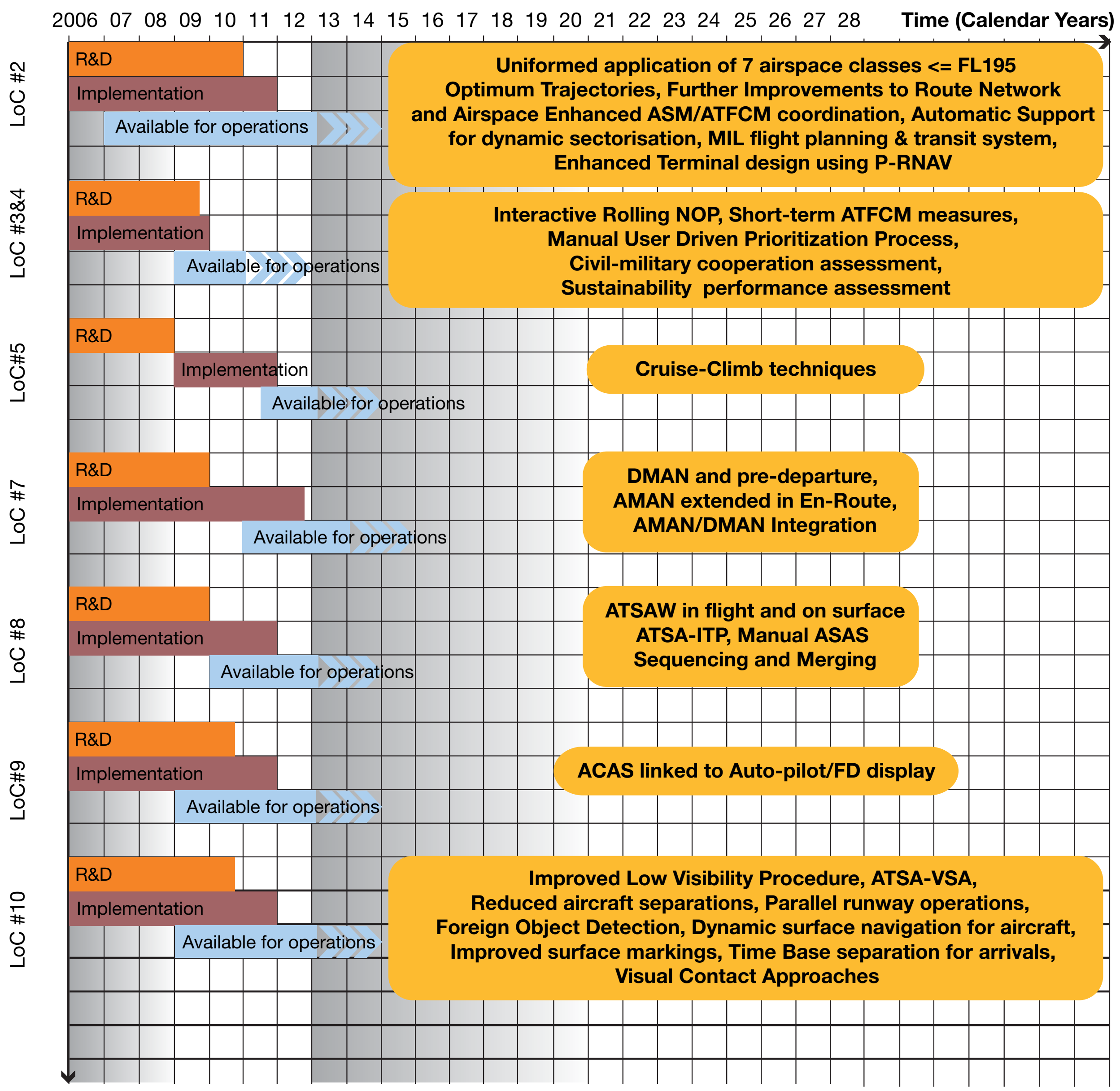



Figure 14: ATM Service Level 1

| LoC#2–Moving from airspace to trajectory based operations |
|---|
| **Uniformed application of 7 airspace classes <= FL 195:** Uniformed application of the rules associated with the 7 ICAO airspace classification at or below FL 195. |
| **Optimum trajectories:** Implement optimum trajectories in defined airspace at particular times. |
| **Further Improvements to Route Network and airspace:** Implement airspace structure (Route/sector) across airspace boundary to better align route and sectors with traffic flow and to accommodate more efficiently the various type of airspace users. |
| **Enhanced ASM-ATFCM coordination:** Deploy collaborative activities to optimise the utilisation of the available capacity based on the continuous assessment of network impact of the expected airspace allocations.<br>Deploy systems and procedures allowing AMC and other parties to design, allocate, open and close military airspace structures on the day of operations. |
| **Automatic Support for dynamic sectorisation:** Deploy dynamic management of airspace/route structures based on pre-defined sector sizing and constraint management in order to pre-deconflict traffic and optimise use of controller work force. |
| **MIL flight planning and transit system (aeronautical data):** Deploy filing of flight plans in a common format (=ICAO FPL format) for military flights i.e. GAT, mixed OAT/GAT and all Operational Air Traffic flights for which a filed flight plan is required and the provision of all OAT-IFR flight data and aeronautical information required for the ATM systems support of military aerial operations.<br>Deploy a pan-European OAT-IFR Transit Service (OATTS), which connects national structures and arrangements to form a flexible system facilitating OAT-IFR flights across Europe. |
| **Enhanced Terminal design using P-RNAV:** Deploy RNAV routes to facilitate improvements in the efficiency and capacity of Terminal Airspace through the provision of increased flexibility and reduced route separation. Includes also the deployment of environmental-friendly procedures like steep and curved approaches. Steep final approaches can be supported by Approach Procedures with Vertical Guidance (APV) with different Minima decision (from LNAV/VNAV to LPV or RNPx). |
| **R&D** |
| Develop and validate the Airspace Allocation and Usage concepts by formalisation and modelling of Traffic Demand and Capacity Balancing (DCB) and Airspace Management (ASM) scenarios.<br>Develop and validate the interaction of different actors for different time horizon and scenarios. Assess system support needed for optimising the interactions between actors and processes.<br>Develop airspace design guidance material for TMA merging techniques based on P-RNAV.<br>Identify divergences of flight planning provisions & procedures for military flights. Elaborate requirements on civil-military flight plan inter-operability related to the SESAR concept of Military Mission Trajectory and its impact on military flight planning needs. Analyse convergence of the military flight planning with the ICAO Future Flight Plan. Determine Flight plan security requirements for State aircraft flights in the SESAR environment, in relation to those for scheduled, non-scheduled and private flights. Identify Military needs in terms of validated aeronautical data not covered in ICAO AIP. Assess applicability of civil standards (e.g. AIXM) for military aeronautical data.<br>Consolidate rules (EUROAT) and identify mechanisms criteria and structures to enable the accommodation within EATMN of military aerial operations conducted as OAT-IFR in a way that improves ATM efficiency and cost effectiveness, reducing fragmentation and duplication of ATM infrastructure. This includes: development of new simulation systems that reflect characteristic military en-route and airspace requirements, harmonisation of military OAT flight plan and the development and validation of solutions to promote the compatibility of military aeronautical data with civil standards (including security aspects). A Pan-European OATTS also entails the need to identify standardised and performance-based CNS requirements interoperable with civil requirements.<br>Develop and validate simulation tools to support Airspace Reservation dimensions and locations. |
| **LoC#3 and LoC#4 - Collaborative Planning using the NOP / Managing the network** |
| **Interactive Rolling NOP[7]:** Implement interactive Network Operation Plan providing an overview of the ATFCM situation from strategic planning to real-time operations readily available online to stakeholders for consultation and update as and when needed subject to access and security controls. |
| **Short Term ATFCM measures:** In order to close the gap between ATC and ATFCM, operational procedures to enhance scenario sharing are deployed which involve coordination between more than one ACC, the Airport Operations and the CFMU. The aim is to maximise the efficiency of the system using flow management techniques close to the real time operations. |
| **Manual User Driven Prioritization Process (UDPP):** Implement and expand use of manual UDPP to enhance capacity and efficiency. |
| **Civil-military cooperation assessment:** Implement and monitor Military KPIs on Airspace Efficiency, Mission Effectiveness and Flexibility and agree civil-military KPIs. |
| **Sustainability performance assessment:** ATM Performance Monitoring is implemented through network efficiency indicators (in particular for Environment and Military aspects) to monitor the performance of the ATM network. Deploy and monitor efficiency indicators to describe the environmental performance of the ATM network. |

7 Moved from Service Level 0 in D4 to Service Level 1 in D5 due to recent developments

**R&D**

Develop dynamic coordination process involving more than one ACC, the Airport Operations and the Network managers. Validate its feasibility and expected optimisation in capacity allocation against network throughput and achieved/expected balance in providing capacity. Elaborate and validate the process to handle pro-active scenarios (known events) as well as re-active scenarios (unplanned, but prepared) for mitigating the consequence of critical events.

Define and validate, the ATM network environmental performance indicators, as well as civil-military coordination monitoring processes and related measurable KPIs. Define models to quantify noise and other environmental loads in airport environment, leaving quantitative assessment of local pollution levels to local policy decision making.

### LoC#5–Managing business trajectory in real time

**Cruise-Climb Techniques:** Deploy coordination of optimised En-Route Cruise-Climb setting between pilot and controllers so as to allow aircraft to climb as weight is decreased though fuel burn. This results in more optimised trajectories.

**R&D**

Determine the modifications necessary to ground systems (and potentially airborne systems) to enable the use of cruise-climb techniques.

### LoC#7-Queue management tools

**DMAN and pre-departure:** Introduce Departure Management synchronised with pre-departure sequencing.

**AMAN extended in En-Route:** Introduce Arrival Management Extended to En-Route Airspace.

**AMAN/DMAN Integration:** Introduce integrated Arrival Departure Management for full traffic optimisation, including provision of assistance to the controller within the TMA to manage mixed mode runway operations, and identify and resolve complex interacting traffic flows.

**R&D**

Define and validate the appropriate scope of AMAN operations within the scope of temporal horizon and geographical areas

Define and validate principles on how to best integrate arrival and departure management constraints.

### LoC#8-New separation modes

**ATSAW in flight and on surface:** Deploy Airborne Traffic Situation Awareness (ATSAW) in the cockpit by displaying surrounding traffic while airborne and on the airport surface.

**ATSA-ITP:** Deploy Airborne Traffic Situation Awareness In Trail Procedure (ATSA-ITP) in Oceanic Airspace.

**Manual ASAS S&M:** Deploy ASAS Manually Controlled Sequencing & Merging operations in applicable TMAs, requiring the pilot to follow the speed commands manually.

**R&D**

Asses benefits of Manual S&M for different category of TMAs in the ECAC Area. Analyse its impact on runway throughput of relative Time Based Separation (ASAS) vs. Absolute Time Based Separation (RTA) Vs Absolute Time based separation (RTA) followed by relative time-based separation (ASPA S&M). Analyse and compare the use of single or multiple merging points for sequencing arrivals to the airport. Assess benefits of ASEP ITP over ASPA-ITP. Study how UAS Operations may be integrated with other managed air traffic in an ASAS Separation environment.

### LoC#9 – Independent Cooperative ground and airborne safety nets

**ACAS linked to Auto-pilot/FD display:** Enhanced ACAS through use of Autopilot or Flight Director.

### LoC#10- Airport Throughput, Safety and Environment

**Improved Low Visibility Procedure:** Introduce improved operations in low visibility conditions through enhanced ATC Procedures collaboratively developed at applicable airports involving in particular an harmonised application across airports and the use of optimised separation criteria. Deploy final approaches with vertical guidance procedures to enable Cat I like operations.

**ATSA-VSA:** Introduce enhanced Visual Separation on Approach (ATSA-VSA), to assist crews to achieve the visual acquisition of the preceding aircraft and then to maintain visual separation from this aircraft.

**Reduced aircraft separations:** Introduce new procedures whereby under certain crosswind conditions it may not be necessary to apply wake vortex minima. Introduce fixed reduced separations based on wake vortex prediction.. Introduce Constant time separations independent of crosswind conditions and wake vortex existence are introduced.

**Parallel runway operations:** Reduce dependencies between runways by implementing more accurate surveillance techniques and controller tools as well as advanced procedures.

**Foreign Object Detection:** Implement system providing the controller with information on Foreign Object Debris detected on the movement area.

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| **Dynamic surface navigation for aircraft:** Introduce guidance assistance to airport vehicle drivers through the provision of an airport moving map showing taxiways, runways, fixed obstacles, and their own mobile position.; also introduce tools that increase the airport vehicle drivers Traffic Situational Awareness (TSA) through the provision of information regarding the surrounding traffic (incl. Both aircraft and airport vehicles) during taxi and runway operations displaying it in the vehicle driver's cockpit.<br>Introduce Guidance Assistance to Aircraft on the Airport Surface using CDTI moving map display including dynamic traffic context information and status of runways and taxiways, obstacles, route to runway or stand with ground signs (stop bars, centreline lights, etc.) are triggered automatically according to the route issued by ATC. |
| **Improved surface markings:** Introduce improvements in lay-out of taxiway and signalling of location of runways with respect to the terminal/apron, including better placed runway crossings, use of additional perimeter taxiways, avoiding alignment of the main taxiways with entries or exits to prevent runway incursions. |
| **Time Base separation for arrivals:** Introduce time based separation procedures for arrivals. |
| **Visual Contact Approaches:** Introduce visual contact approaches. |
| **R&D** |
| Develop Guidance Material for best practices on flight deck procedures for runway crossing, while taxiing and the communication with the air traffic controller regarding aerodrome signage, markings and lighting. Validate the use of weather information to improve predictability and reliability of managing the traffic on the airport surface (e.g. meteorological information in respect of aircraft de-icing and prediction of thunderstorm). Assess the feasibility of using meteorological information to predict braking performance on surface airport.<br>Develop and validate requirements for improved information provision to aircraft and vehicles of their position, routing and also information regarding taxiways, runways and fixed obstacles.<br>Develop and validate procedures to improve separation through exploitation of Wake Vortex prediction for arrivals and departures.<br>Consolidate approval of VFR procedures for IFR traffic operations. |

### 3.1.3 ATM Service Level 2

Service Level 2 introduces the fundamental changes underpinning the SESAR Concept of Operations thanks to the progressive implementation of an information rich and information sharing environment with SWIM supporting the Shared Business Trajectory. More and more user-preferred trajectories will be accommodated along with Functional Airspace Block (FAB) implementation over Europe, enabling more direct routes in upper airspace. The User Driven Prioritisation Process (UDPP) will be applied defining prioritisation as the result of a collaborative process involving all partners. New modes of separation will be introduced (2D-PTC) and ASAS Spacing applications will be introduced in terminal areas. Advanced environmental friendly operations will be used in higher density terminal areas, with the introduction of 3D trajectory management and new controller tools. Surface movement operations will benefit from increased automation and improved surface navigation. Positional awareness will be improved through the application of visual enhancement technologies.

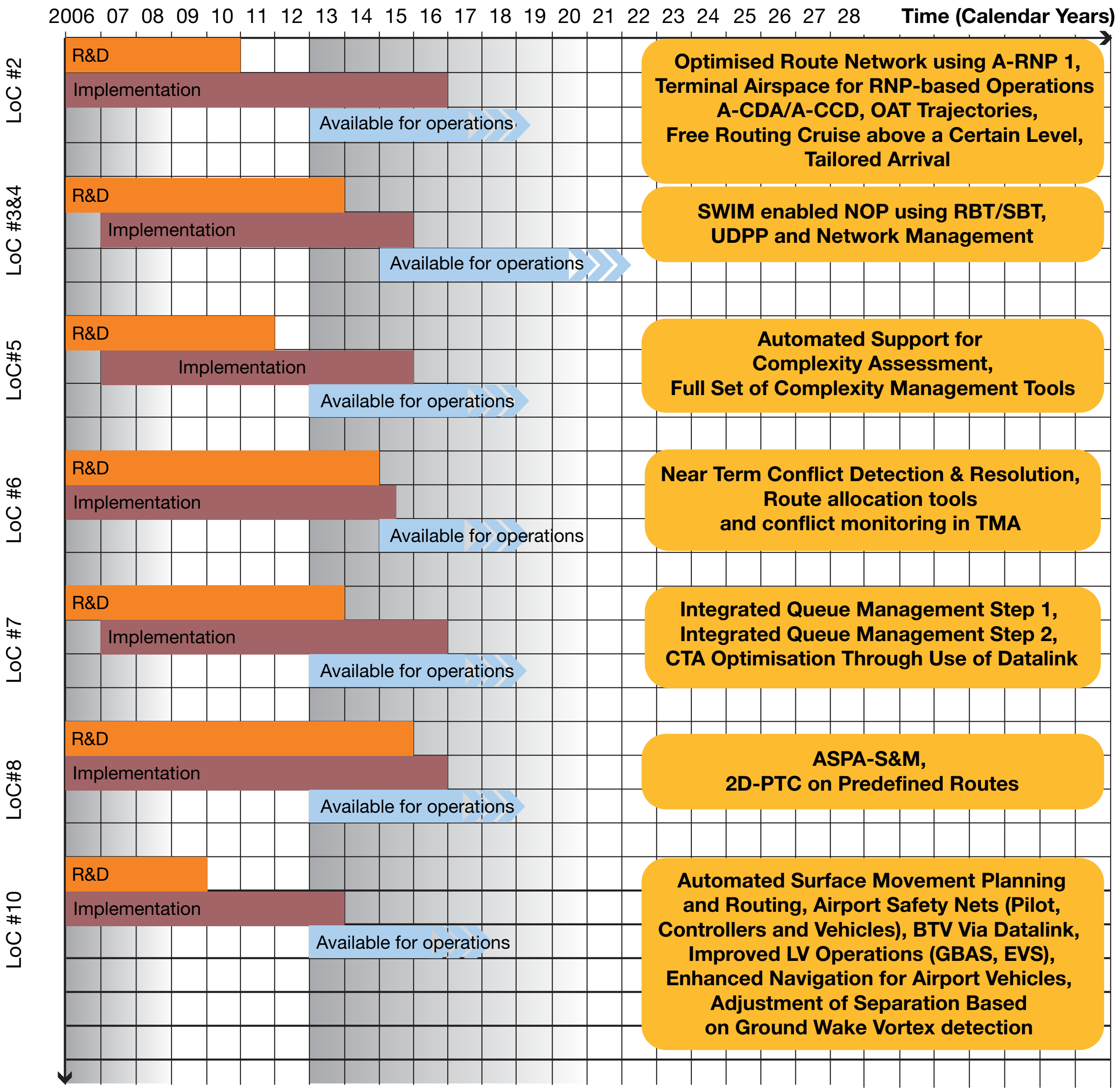


Figure 15: ATM Service Level 2

| LoC#2–Moving from airspace to trajectory based operations |
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| **Optimised Route Network using Advanced RNP 1 (new RNP navigation specification for Terminal airspace routes):** Spacing between routes is reduced where required, with commensurate requirements on airborne navigation capabilities; tactical parallel offset is increasingly used as alternative to vectoring. |
| **Terminal Airspace for RNP-based Operations:** Implement A-RNP1 SIDs and STARs; redefine holding areas in terms of size and location. Introduce RNP-based instrument procedures with vertical guidance through the provision of stabilised approaches, and therefore reduce the potential for CFIT (Controller Flight Into Terrain). |
| **A-CDA:** Deploy Advanced Continuous Descent Approach (ACDA) in higher traffic density, optimised for each airport arrival procedure, enabling aircraft to fly, as far as possible, their individual optimum descent profile; deploy Tailored Arrival routing from Top of Descent (TOD) to Initial Approach Fix (IAF) or to runway taking in account other traffic and constraints.<br>**A-CCD:** Deploy Advanced Continuous Climb Departure (ACCD) in higher traffic density. |
| **OAT Trajectories:** Deploy interfacing of Military Mission Trajectories with Business Trajectories. |
| **Free Routing Cruise above a Certain Level:** Deploy free routing in Upper Airspace independent from route network in cruise. |
| **Tailored Arrival:** Deploy Tailored Arrival procedures in appropriate airport area. |
| **R&D** |
| Elaborate military area sharing concept in respect of flight planning process, classes of traffic, aircraft capabilities and phases of flight. Elaborate and then demonstrate the feasibility and benefits of the advanced flexible use of airspace (AFUA) (e.g. military variable profile area (MVPA), variable geometry area (VGA) and dynamic mobile area (DMA)).<br>Elaborate A-CDA, A-CCD and tailored arrivals in respect of: evolution towards full 4D operation; use of Datalink to coordinate trajectories in advanced climb and descent operations. Assess the impact of advanced climb and approach/descent procedures on airport operations and runway capacity; feasibility of A-CDA and tailored arrivals procedures in a high traffic density/complexity environment.<br>Validate where a fixed Route Network is still needed and the method of interfacing Free Route airspace with a fixed Route Network (including Rules and Procedures, impact on workload, economic justification, etc.).<br>Assess the transition aspects related to accommodating OAT routes in a free route environment. Study military aircraft capabilities to support separation modes and possible needs in terms of ground-based 4D trajectory support. |
| **LoC#3 and LoC#4 - Collaborative Planning using the NOP / Managing the network** |
| **SWIM enabled NOP using RBT/SBT:** Implement processes enabling the publication of Shared Business/Mission Trajectories (SBT) by airspace users. The Shared Business / Mission Trajectory (SBT) is made widely available for ATM planning purposes to authorized users. Reference Business/Mission Trajectories (RBT) are agreed through Collaborative Flight Planning. |
| **UDPP and Network Management:** Deploy the User Driven Prioritisation Process (UDPP) and implement the network management function to assist airspace users in the UDPP process. |
| **R&D** |
| Analyse impact of climatic factors for optimisation of route and long-term planning.<br>Develop new ways for the Collaborative flight planning process leading to the publication of RBT (a complete Flight Planning concept should define all of the information that is needed by ATM from the Airspace User at all stages leading up to the flight).<br>Study how to integrate airports in to SBT/RBT revisions process.<br>Define and Validate the User Driven prioritisation process and procedures to optimize Demand and Capacity Balancing management.<br>Develop and validate the visualisation tools covering all stakeholders' information access and performance needs to operate NOP. In particular, develop facilities that support Airspace Users in planning their 4D trajectories/missions (SBTs) through the NOP process while taking into account airspace availability, other traffic operations, airport's operational plans, Meteo and the Users' own exploitation plans.<br>Define and validate all factors and triggering conditions, the roles & responsibility of the different actors impacting the UDPP process (e.g. temporal horizon,. major hub airports, Departure congestion, Arrival congestion, Airspace congestion, categories of airspace users).<br>Assess the impact of the generalisation of UDPP process within ECAC on synchronisation and stability of NOP process.<br>Elaborate the concept to establish a clear and beneficial frontier between dynamic ATFCM/DCB and complexity management.<br>Define and validate operational process and procedures aiming at balanced and minimised constraint management mechanism including Airlines preferences.<br>Develop and validate supporting tools for the elaboration, assessment, negotiation and implementation of DCB/ATFCM scenarios. |

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| **LoC#5 - Managing Business Trajectory in real time** |
| **Automated Support For Complexity Assessment:** Deploy ground systems to continuously monitor and evaluate traffic complexity (in a certain airspace volumes), in order to predict upcoming congestions and support dynamic airspace management.<br>Support ATCOs in identifying and resolving local complex situations: assessment of evolving traffic patterns and evaluation of opportunities to de-conflict or to synchronise trajectories. |
| **Full Set of Complexity Management Tools:** Deploy Automated Controller Support for Trajectory Management and Ground based Automated Support for Managing Traffic Complexity Across Several Sectors (e.g. MSP). |
| **R&D** |
| Identify and validate airspace volumes subject to complexity management and required level of accuracy.<br>Analyse how the complexity assessment can be integrated in ATFCM processes. Specify and develop tools to predict complexity and provide the capability to trial complexity reduction measures. Define responsibilities between regional and sub-regional/local network management functions.<br>Develop and validate operational procedures and analyse their implications (e.g. human machine interaction on workload, safety) for trajectory revision. Assess cost and benefits of RBT process.<br>Validate adapted sector team operations to new roles in real environment. Determine usability of complexity data for capacity calculations.<br>Assess impact of different separation modes on determination of traffic complexity and controller task-load. |
| **LoC#6 - Collaborative ground and airborne decision making tools** |
| **Near Term Conflict Detection & Resolution:** Deploy automated Support for Near Term Conflict Detection & Resolution and Trajectory Conformance Monitoring.<br>**Route allocation tools and conflict monitoring in TMA:** Introduce ground system route allocation tools to assist the controller in managing the potentially large number of interacting routes (automatic selection of the optimum conflict-free route when triggered by a specific event). Deploy ground system situation monitoring to assist the controller in detecting and assessing the impact of deviations from clearances. |
| **R&D** |
| Specify near term conflict detection tools. Elaborate the appropriate data sources for the automation process.<br>Elaborate the concept and specify the automated assistance tool for planning, preventing and detecting near term conflicts in TMA operation. Analyse the potential for the combined/complementary presentation of warnings from the ground and air conformance monitoring tools. Develop and specify the automated assistance necessary to enable real-time, optimum, conflict-free route allocation. Investigate and determine the optimum lead-time for dynamic route allocation that provides the best balance between cockpit/ controller workload and capacity, including possible airborne system modifications to support these procedures. |
| **LoC#7 - Queue Management Tools** |
| **Integrated Queue Management Step 1:** Integrate Surface Management Constraint into Arrival Management; Integrate Surface Management Constraint into Departure Management; Departure Management from Multiple Airports; Surface Management Integrated With Departure and Arrival Management. |
| **Integrated Queue Management Step 2:** Integrate arrival Management into Multiple Airports; Optimised Departure Management in the Queue Management Process; Integrate Arrival / Departure Management in the Context of Airports with Interferences (other local/regional operations). |
| **CTA Optimisation Through Use of Datalink:** All ATM partners work towards achieving Controlled Time of Arrival (CTA) through use of Datalink to optimize arrival sequence. |
| **R&D** |
| Evaluate the use of CTA techniques by AMAN in a mixed mode environment where not all aircraft are CTA (RTA) capable. Assess the impact on runway throughput of relative time-based separation (ASPA S&M) versus Absolute Time based separation (RTA).<br>Elaborate and validate the scope/boundaries of s urface management/departure management/ arrival management and identification of overlaps if any.<br>Elaborate the scope of CDM in arrival management.<br>Develop the concept for interacting closer arrival traffic in multiple airports, within a single TMA.<br>Elaborate and validate the scope/boundary of surface management/departure management/arrival management.<br>Analysis of the interaction between DCB and departure management.<br>Develop and validate the A-CDM and AMAN/DMAN integration concept. Develop and validate operational procedures.<br>Develop and validate how Collaborative Planning will optimise network operations through applications of SWIM and constraints on the operation of AMAN, DMAN coordinated by A-CDM |

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| **LoC#8 - New Separation Modes** |
| **ASPA-S&M:** Introduce enhancements to arrival sequencing through the use of ASAS in its Sequencing and Merging application i.e. Airborne Spacing Sequencing and Merging (ASPA-S&M). The flight crew ensures a time or distance based spacing from designated aircraft as stipulated in new controller instructions. |
| **2D-PTC on Predefined Routes:** Deploy Precision Trajectory Clearances on 2 Dimensions based on pre-defined 2D Routes. |
| **R&D** |
| Develop further the 2D precision trajectory methods and specify the expected performance requirements in respect to the potential costs.<br>Assess the ASPA-S&M application for expected benefits versus absolute time based separation methods such as 2D Precision Trajectory Operations." |
| **LoC#10 - Airport Throughput, Safety and Environment** |
| **Automated Surface Movement Planning and Routing:** Introduce Automated Assistance to Controller for Surface Movement Planning and Routing. |
| A**irport Safety Nets (Pilot, Controllers and Vehicles):** Introduce tools to detect potential conflicts/incursions involving mobiles (and stationary traffic) on runways, taxiways and in the apron/stand/gate areas providing alarms to controllers, pilots, and vehicle drivers together with potential resolution advice. |
| **BTV Via Datalink:** Deploy automated braking to vacate at a pre-selected runway exit coordinated with ground ATC through Datalink and based on BTV avionics that controls the deceleration of the aircraft to a fixed speed at the selected exit. |
| **Improved LV Operations (GBAS, EVS):** Introduce GNSS / GBAS for precision approaches and EVS (Enhanced Vision System) to support final approach and surface operation Low Visibility Conditions |
| **Enhanced Navigation for Airport Vehicles:** Introduce tools that increase the airport vehicle drivers Traffic Situational Awareness (TSA) through the provision of information regarding the dynamic traffic context including status of runways , taxiways and obstacles. |
| **Adjustment of Separation Based on Ground Wake Vortex detection:** Implement dynamic Adjustment of Separations based on Real-Time Detection of Wake Vortex. |
| **R&D** |
| Develop and validate procedures to improve safety of operation on the airport surface through the use of alert and advisories presented to various actors (e.g. pilot, controller airport vehicle drivers).<br>Develop and validate coordination/integration of airside operation with airport ATC operation to improve airport surface operations.<br>Develop and validate traffic management on airport surface, including taxi routing.<br>Develop and validate pre-selected runway exit coordination between airport ATC and aircraft, exploiting Brake To Vacate and Datalink full functionalities. Further maximize runway throughput through the development and validation of ground based wake vortex real time detection.<br>Develop and validate precision approach and landing based on GBAS (and SBAS where appropriate for regional airfields) and/or EVS capability, maintaining operations under adverse conditions, including low visibility. |

### 3.1.4 ATM Service Level 3

The use of free routing is extended, and a new model of airspace categories will be introduced to pave the way to the target two categories contemplated in the SESAR Concept of Operations. This is complemented by airspace organisations measures for an extensive dynamic management of En-Route and terminal airspace. ATC automation will benefit from full use of 4D shared trajectory environment, thus making it possible the implementation of a full set advanced controller tools as well as further assistance to controller in support of precision trajectory operations and effective queue management. First ASAS separation applications will be introduced. Flight deck automation will be increasingly used on the airport surface.

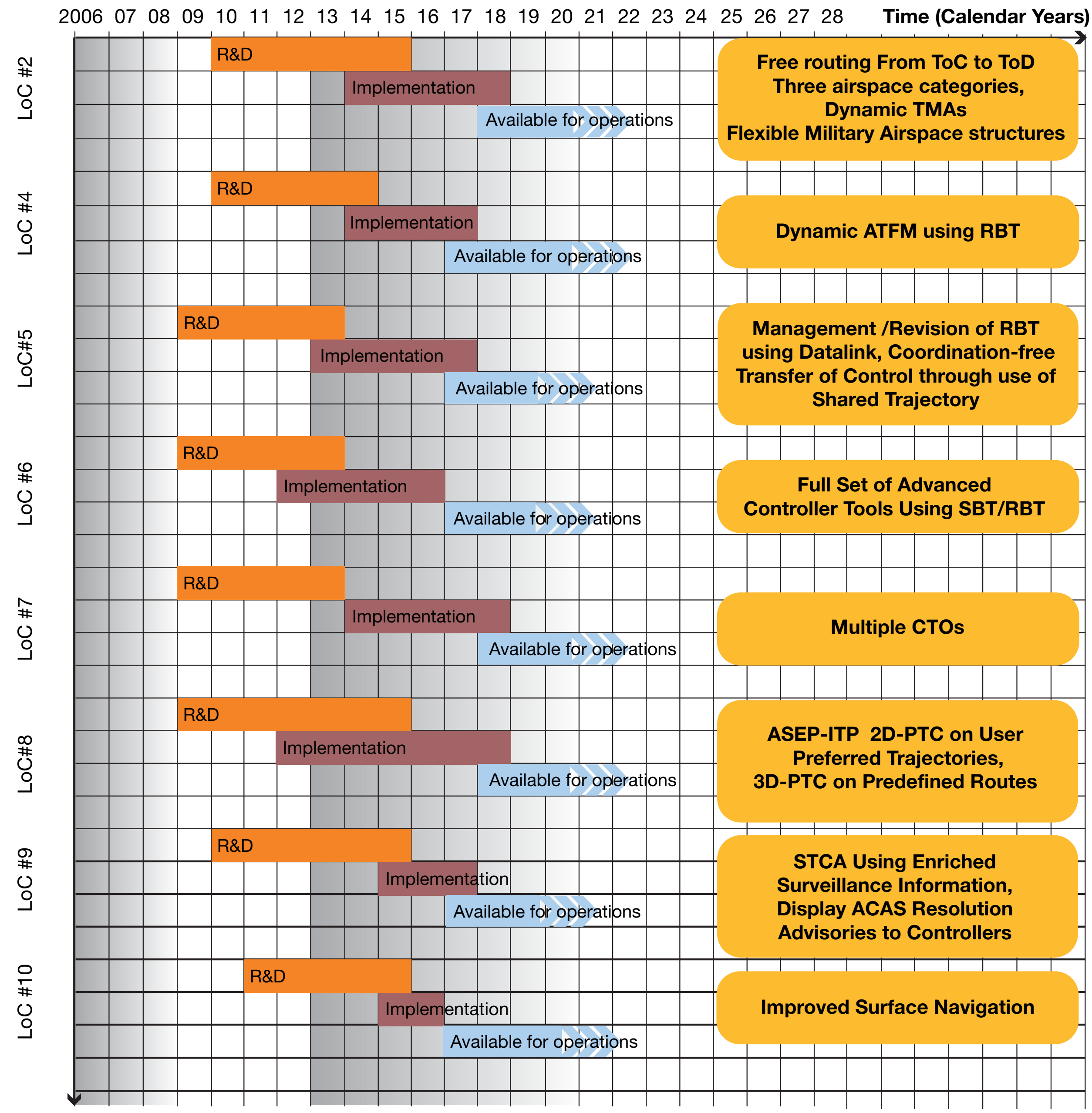


Figure 16: ATM Service Level 3

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| **LoC#2–Moving from airspace to trajectory based operations** |
| **Free Routing from ToC to ToD:** Deploy Free Routing from ToC to ToD; Maintain Pre-defined ATS Routes Only When and Where Required. |
| **Three airspace categories:** Deploy the new model of airspace based on 3 categories: N (iNtended), K (Known), U (Unknown). |
| **Dynamic TMAs:** Deploy dynamic adjustment of airspace boundaries of terminal airspace according to traffic patterns and runways in use. |
| **Flexible Military airspace structures:** Deploy Europe-wide shared use of Military Training Areas and Flexible Military Airspace Structures (FMAS) based on ad-hoc structure delineation (not covered by pre-defined structures and/or scenarios). |
| **R&D** |
| Validate where a fixed Route Network is still needed and the method of interfacing Free Route airspace with a fixed Route Network (including Rules and Procedures, impact on workload, economic justification, etc.)<br>Validate rules and procedures (including economic assessment) for operations in Type N airspace with minimum aircraft equipage. Assess impact on military operations. |
| **LoC#4 - Managing the ATM Network** |
| **Dynamic ATFM using RBT:** Use 4D trajectory updates in the ATFCM process in order to optimise the network usage. Dynamic ATFCM management objective is to take benefit of the 4D trajectory updates for using capacity opportunities and for supporting the queue management and the achievement of the CTA. |
| **R&D** |
| Assess the integration with the Dynamic ATFCM/DCB with regard to expected performance. Elaborate the concept to establish a clear and beneficial frontier between dynamic ATFCM/DCB and complexity management. Define and validate operational process and procedures aiming at balanced and minimised constraint management mechanism including Airlines preferences. |
| **LoC#5- Managing Business Trajectory in real time** |
| **Management Revision of RBT using Datalink:** deploy digital data communication applications and services as the main means of communication even though there will remain circumstances in which clearances and instructions are issued by voice. |
| **Coordination-free Transfer of Control Through use of Shared Trajectory:** Implement coordination-free transfer of control using shared 4D trajectories, even though coordination may be required in non-nominal situations and when either time critical information or trajectory changes must be communicated. |
| **R&D** |
| Define ownership and information content of the shared data necessary to suppress the coordination for transfer of control. Define procedures for non-equipped aircraft and degraded mode coordination strategy. |
| **LoC#6 - Collaborative ground and airborne decision making tools** |
| **Full Set of Advanced Controller Tools Using SBT/RBT:** Deploy controller tools updated with better performance conflict detection using shared 4D trajectories (reduced uncertainty on trajectory prediction). Introduce conflict dilution by upstream action on speed (TC-SA - Trajectory Control Through Ground Based Speed Adjustments). |
| **R&D** |
| Analyse alternative ways to support controllers in monitoring the traffic.<br>Validate the use of Shared 4D Trajectory as a means to detect and reduce conflicts.<br>Validate the usability of automated support tools and conformance monitoring to prevent conflicts.<br>Analyse the benefit, gained by reduced controller workload due to automated assistance.<br>Elaborate the concept and analyse the usability of shared trajectories for conflict mitigation; define the data to be provided by the airspace user. Define and validate the concept of conflict dilution through the use of upstream speed management. |
| **LoC#7 - Queue Management Tools** |
| **Multiple CTOs:** Introduce Multiple Controlled times of Over-fly (CTOs) through use of Datalink. The CTOs are ATM imposed time constraints set on successive defined merging points for queue management purposes. The CTOs are computed by the ground actors on the basis of the estimated times provided by the airspace user. |
| **R&D** |
| Assess the management of multiple time constraints to address both airspace and airport capacity shortfalls.<br>Assess the potential effects of the application of multiple RTA and the constraints resulting from the aircraft performance envelope, flexibility or economic profile. |

| LoC#8 - New Separation Modes |
|---|
| **ASEP-ITP:** Deploy separation application In-Trail Procedure (ASEP-ITP) for use En-Route in an oceanic environment as a further step toward ASAS application deployment. |
| **2D-PTC on User Preferred Trajectories:** Deploy Precision Trajectory Clearances on 2 Dimensions based on User preferred trajectories. |
| **3D-PTC on Predefined Routes:** Deploy Precision Trajectory Clearances on 3 Dimensions based on pre-defined 3D Routes. |
| **R&D** |
| Evaluate the ASAS S&M and ASEP-ITP applications in mixed mode of operations. Analyse compatible algorithms for ground based tools and airborne separation applications |
| **LoC#9 - Independent Cooperative ground and airborne safety nets** |
| **STCA Using Enriched Surveillance Information:** Improve ground based safety net performance using widely shared aircraft position and intent data. |
| **Display ACAS Resolution Advisories to Controllers:** Introduce Resolution Advisory (RA) downlink informing Controllers automatically when ACAS (airborne collision avoidance system) generates an RA. |
| **R&D** |
| Develop and validate provision to controllers of a reliable alerting system based upon all the surveillance information available. |
| Develop and validate the coordination of ATC and flight deck warnings as well as appropriate presentation, so that the nuisance-warning rate can be optimised. Analyse possible information overload for the controller due to the RA Downlink.<br>Specify principles for Resolution Advisory (RA) priority over any instruction that may be triggered by ground safety nets or ATC tools. |
| **LoC#10 - Airport Throughput, Safety and Environment** |
| **Improved Surface Navigation:** Introduce tools to enhanced Trajectory Management through Flight Deck automation using advanced aircraft automated systems such as auto-brake (making it impossible for an aircraft to cross a lit stop bar) and auto-taxi (optimising speed adjustment). |
| **R&D** |
| Develop and validate on-board systems to support auto-brake and auto-taxi. |

### 3.1.5 ATM Service Level 4

Service Level 4 contributes to the transition to the ATM Target Concept with full implementation of enhanced trajectory management through 3D precision clearances for user preferred trajectories and of ASAS cooperative separation applications. For airports remote tower operations are introduced and specific procedures based on synthetic vision system are defined.

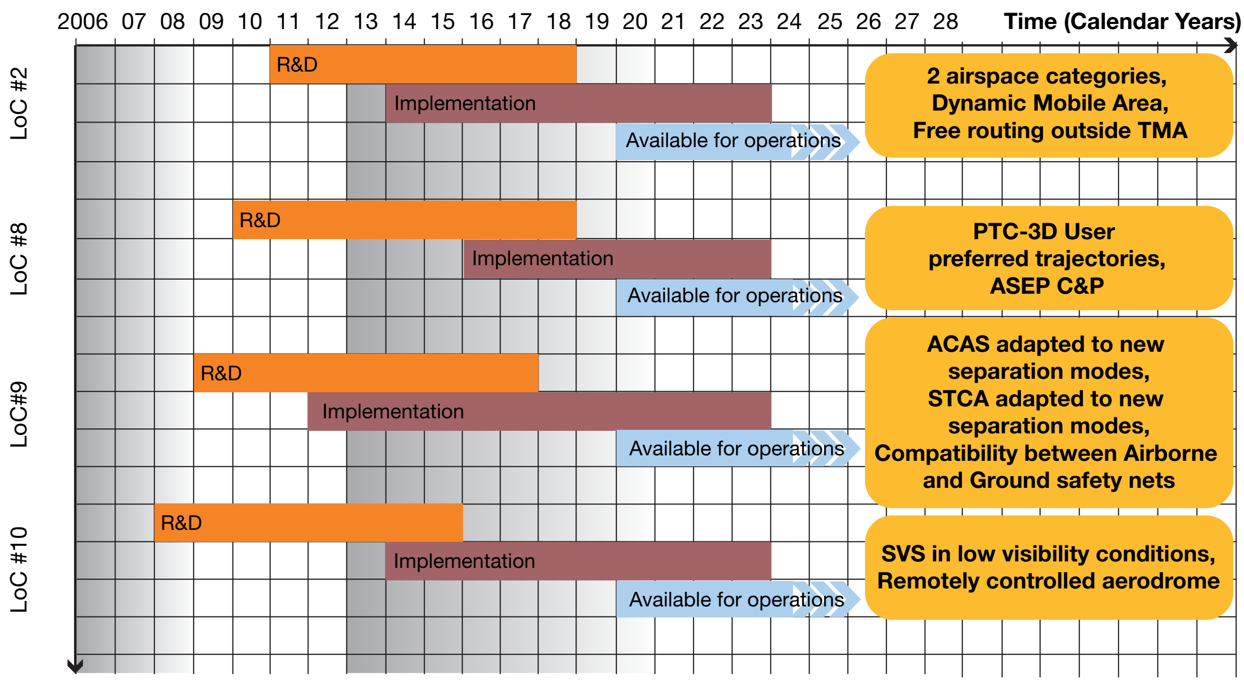


Figure 17: ATM Service Level 4

| LoC #2–Moving from airspace to trajectory based operation |
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| **2 airspace categories:** Remove Category K (Known) airspace. |
| **Dynamic Mobile Area:** Deploy temporary mobile airspace exclusion areas (Dynamic Mobile Areas (DMA)). |
| **Free routing outside TMA:** Deploy use of Free Routing from TMA exit to TMA entry not operating in high complexity airspace. |
| **R&D** |
| Provide economic justification for removing type K airspace. Assess the impact of the transition path towards reduction to 2 airspace categories. Develop and validate minimum airspace segregation requirements.<br>Elaborate and validate the concept of Dynamic Mobile Areas (DMA) including military missions.<br>Assess of the feasibility and benefits of the advanced flexible use of airspace (AFUA), in particular with regards to its integration with the SBT/RBT definition and revision, the dynamic DCB and the complexity management processes.<br>Assess impact of the interaction of free routing with AMAN/DMAN sequencing, new airborne separation modes the Business/Mission Trajectory management, continuous descent and climb procedures, complexity management, capacity planning, DCB/ASM, scenario management and flight planning processes. |
| **LoC #8–New Separation Modes** |
| **3D-PTC User preferred trajectories:** Deploy 3D Precision Trajectory Clearances (3D-PTC) for Aircraft flying User Preferred Trajectories (Dynamically applied 3D routes/profiles). |
| **ASEP C&P:** Deploy delegation of the separation by the controller to an aircraft for Crossing and Passing manoeuvres relative to designated target aircraft. |
| **R&D** |
| Develop and validate 3D Precision Trajectory (3D-PTC) separation methods.<br>Develop and validate the operating concept for the ASEP C&P and Self Separation applications in mixed mode of operations. In particular, evaluate the impact of impact RNP/RCP/RSP on the separation minima (strategic or tactical). |
| **LoC #9–Cooperative ground and airborne safety nets** |
| **ACAS adapted to new Separation modes:** Adapt the ACAS function to ensure it keeps playing efficiently its role of safety net in the context of new separation modes and lower separation minima. |
| **STCA adapted to new Separation modes:** Adapt the STCA function to new separation modes in particular if lower separation minima is considered. |
| **Compatibility between Airborne and Ground safety nets:** Introduce improved compatibility between airborne and ground safety nets. Although ACAS and STCA are and need to stay independent at functional level there is a need for better procedures in order to avoid inconsistent collision detection and resolution. |
| **R&D** |
| Enhance ACAS function so that it can recognise the new separation modes and any false alarms can be minimised, in particular when lower separation minima is considered as a result of the introduction of the delegation of the role of separator, because aircraft may fly in close proximity to each other with geometries that would trigger ACAS as we know it today.<br>Enhance STCA function so that it is able to recognise the new separation modes and avoid triggering false alarms and hence optimising the nuisance alarm rate for the controller's benefit.<br>Analyse the impact of ACAS on ATC systems. Improve means to avoid inconsistent collision detection and solution by ACAS and STCA. Develop and validate a prioritisation process, which shall be followed by airborne and ground safety nets when operating together. |
| **LoC #10–Airport Throughput, Safety and Environment** |
| **SVS in low visibility conditions:** Introduce a synthetic vision system in the cockpit, which provides the pilot with a synthetic/graphical view of the environment, for use in low visibility conditions, using terrain imagery and position/attitude information. |
| **Remotely controlled aerodrome:** Deploy remotely provided aerodrome control service. |
| **R&D** |
| Develop and validate the context of remote TWR application in respect to the traffic levels. Develop rules and procedures for the use of remotely operated aerodrome ATC. Assess the level of traffic that can be safely managed under these circumstances. Depending on early results from the R&D and specific regional needs, early implementation (in the 2013 –2015 timeframe) might be achievable.<br>Develop procedures for synthetic vision (SVS) based operations for use in low visibility conditions. |

### 3.1.6 ATM Service Level 5

Main features of Service Level 5 will be the implementation of 4D Precision Trajectory Clearances and the introduction of ASAS Self-Separation in a mixed mode environment. Those changes require extensive feasibility studies and will be completed as result of innovative research and as part of the Master Plan maintenance process.

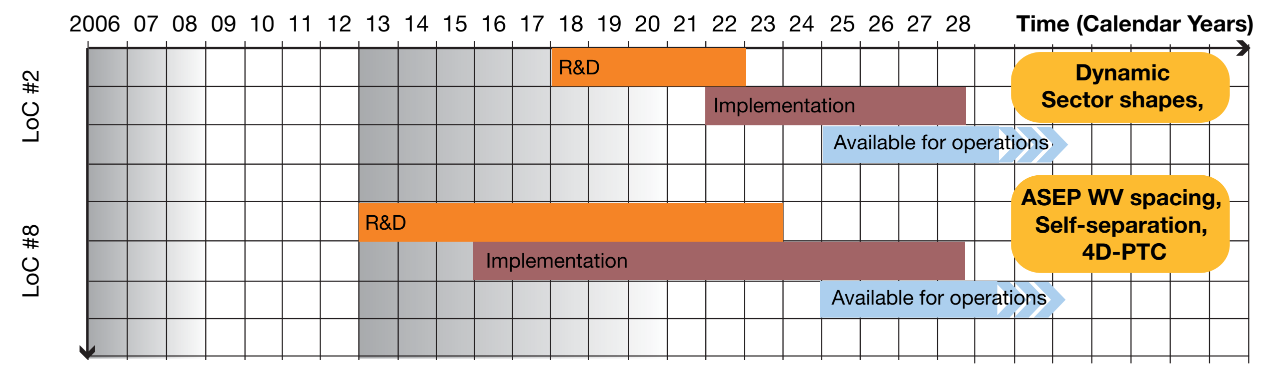



Figure 18: ATM Service Level 5

| LoC#2–Moving from Airspace to Trajectory Based Operations |
|---|
| **Dynamic Sector shapes:** ATC sector shapes and volumes are adapted in real-time to respond to dynamic changes in traffic patterns and/or short-term changes in users' intentions. |
| **R&D** |
| Elaborate the concepts of Dynamic Sectors and Dynamic TMAs in respect of: the operational contexts (airspace, complexity level, traffic mix…) in which they apply. Assess the integration and impact on capacity planning, DCB/ASM, scenario management and flight planning processes. |
| **LoC#8–New Separation Mode** |
| **ASEP WV spacing:** Deploy Self-Adjustment of spacing depending on Wake Vortices. The spacing is adjusted dynamically by the pilot based on the actual position of the vortex of the predecessor. |
| **Self-separation:** Deploy the delegation of the separation by the controller between an aircraft and all the other aircraft in mixed-mode environment through new air broadcast and reception of trajectory data and new onboard conflict detection and resolution functions. |
| **4D-PTC:** Deploy the 4D-PTC using longitudinal navigation performance management from the aircraft. |
| **R&D** |
| Elaborate the concepts of A/A services, including exchange of weather hazards and Wake-Vortexes information.<br>Develop and validate 4D-PTC with extended clearance. This should identify the trajectory management requirements and the separation minima applicable to 4D-PTC with extended clearance and should take into account the improved RNP capability of aircraft.<br>Compare alternative means of separation management like airborne self management; cooperative self-separation for business jet in low density high altitude airspace (e.g. above FL410) should be started as early as possible to validate the self-separation concept. Investigate potential Human Factor impact of the mixed mode operation on both pilots and controllers. |

## 3.2 Supporting Changes

### 3.2.1 Evolution towards System Wide Information Management

Historically, the focus of attention has primarily been on how to improve (algorithms, automated tools and procedures for) decision making in the various functional categories e.g. airspace management, flow and capacity management, separation assurance, sequencing and metering etc. — whereas the purpose of System *Wide Information Management* is complementary. It focuses on improving the information supply chain to and from the above mentioned decision making to improve ATM performance. More details on the relationship between SWIM and ATM Performance are provided in Annex 9.5.

#### 3.2.1.1 Principles used for Building the SWIM Deployment Sequence

The deployment sequence of SWIM is defined taking the following considerations into account:

- SWIM has been recognised as an essential enabler of ATM applications, the principles of which are also applied in, and supplied by, other industries. Technologies enabling SWIM capabilities required by ATM are available. SWIM as a methodology of sharing information can apply to all ATM capability and service levels. In this context "SWIM Capability Level" relates in some cases to an extension of geographical/spatial availability, although different ATM Service Levels may equally need more advanced and/or widespread implementation of SWIM.
- SWIM is an enabler of end-user applications needed in ATM. It is not in itself an ATM end-user application. The concept of SWIM will make information more commonly available and consequently allow its usage by end-user applications. This will further allow not to constrain the implementation of end-user applications by the otherwise necessary full deployment of the relevant airborne and ground capability and to provide benefits at an earlier stage;
- SWIM creates the conditions for advanced end-user applications based on extensive information sharing and the capability of finding the most appropriate source of information;
- For the deployment of SWIM an approach has been selected ensuring that benefits start to accrue at the earliest possible time: this is achieved by migrating simpler end-user applications first. The deployment of SWIM is not dependent on the deployment of ATM changes. SWIM benefits are available even in a largely legacy environment;
- SWIM deployment will require creation of a new Stakeholder role, the Regional SWIM Manager, responsible for the overall SWIM management in the distributed SWIM environment (see section 3.3.8). In addition each Stakeholder is responsible for the adaptation of their systems (e.g. procedures, technical, etc.) and operations in this SWIM distributed environment.

Deployment towards SWIM is split into SWIM Capability Levels (see Figure 19) that are defined for achieving early benefits and the most cost efficient building up of SWIM capability taking into account the need to lead the overall ATM evolution and also to make sure that some benefits can even be gained in the legacy environment:

- SWIM Capability Level 1 with a planned IOC date of 2009;
- SWIM Capability Level 2 with a planned IOC date of 2013;
- SWIM Capability Level 3 with a planned IOC date of 2017.

Each SWIM Capability Level is described in terms of four top-level aspects (illustrated with non-exhaustive types of enablers that would need to be defined, but that are considered essential if SESAR aims are to be achieved in a cost effective way):

- "Institutional" covering the areas of Regulation, Licensing, Liability, and Ownership;
- "Network" in this context refers to the data networks and not the ATM network;
- "Systems" include both ground and airborne systems;
- "End-user Applications" such as Controllers tools, Airborne Decision Making aids, NOPLA.

#### 3.2.1.2 The SWIM Deployment Plan

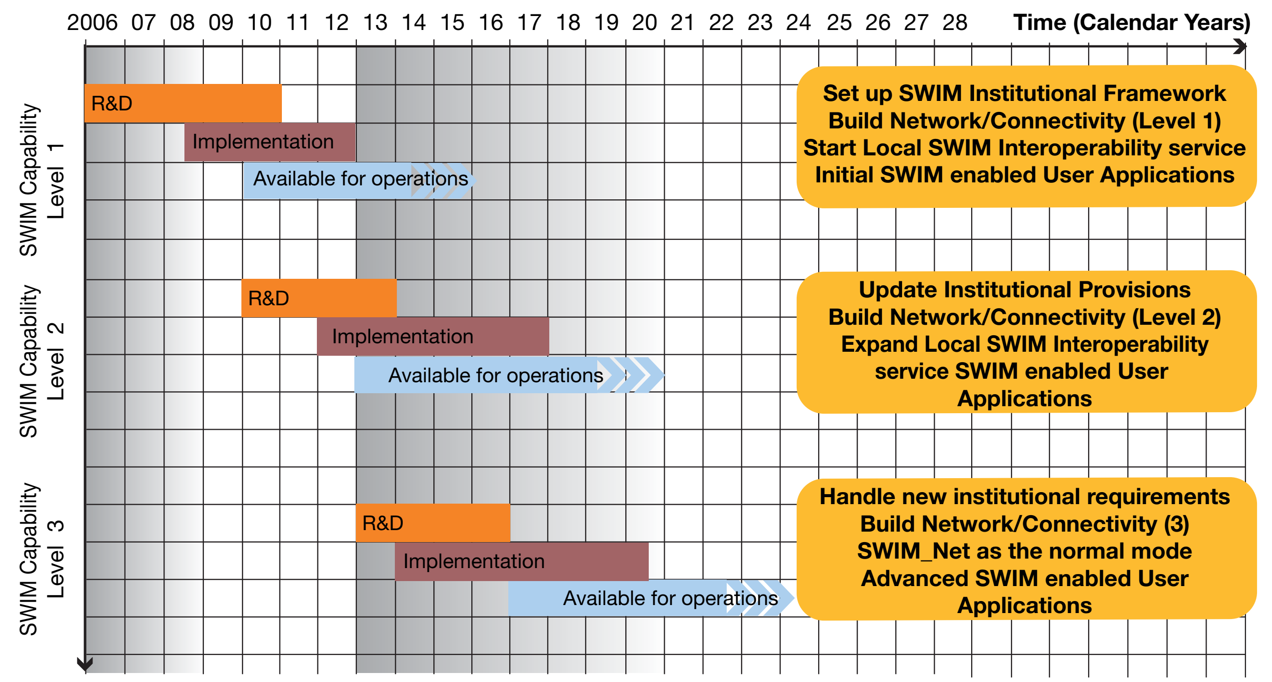



Figure 19: Evolution towards SWIM

## SWIM Capability Level 1 Deployment

**Develop SWIM Institutional aspects**: a set of decisions and rules, which enable the necessary amendments to ICAO and European provisions (e.g. Annex 3, 10, 11, 15, Doc. 4444, 7030 etc.) on which SWIM has an impact to be initiated and carried to approval. The following actions should be undertaken:

- P1.I1 - Define new rules and trigger amendments to existing rules;
- P1.I2 - Identify standards to be used and new standards to be defined (including exchange formats, etc.), develop standards;
- P1.I3 - Agree SWIM security policy;
- P1.I4 - Establish EUR SWIM Management;
- P1.I5 - Agree legacy service provision arrangements;
- P1.I6 - Identify and organise provider categories;
- P1.I7 - Start issuing licences;
- P1.I8 - Organise charging (in accordance with established principles).

This includes extending the scope of aeronautical information and integrating Meteo information in the extended scope.

**Build Network / Connectivity (SWIM Capability Level 1)**

- P1.N1 - Identify common services and assignments. Ensure compatibility with other SWIM-like environments;
- P1.N2 - Select network providers (on the basis of quick start need), build initial connectivity;
- P1.N3 - Promulgate network side standards for “Local SWIM Connectivity Service”;
- P1.N4 - Start deploying mobile connectivity.

**Start Local SWIM Interoperability service in stakeholders’ Systems**

- P1.S1 - Start implementing “Local SWIM Connectivity Service” in partner systems or identify and use existing capability.
- P1.S2 - Implement the common ATM information reference model that will enable the implementation of SWIM information exchange.

**Initial SWIM-enabled User Applications**

- P1.A1 - Transition Airport Collaborative Decision Making (A-CDM) applications from message based to data based operation;
- P1.A2 - Implement flight data/flight plan input applications (e.g. for GA and military);
- P1.A3 - Implement applications for accessing meteorological information (e.g. Aeronautical and Weather Information Provision);
- P1.A4 - Update Flight Data Processing applications to accept shared trajectory information from outside sources (e.g. Flight Operations Centre or later on-board Flight Management);
- P1.A5 - Implement first version of the interactive Network Operations Planner (NOPLA);
- P1.A6 - Update airspace user applications to enable use of NOPLA;
- P1.A7 – Improve Flight Data Consistency and Interoperability;
- P1.A8 – Continue to evolve from Aeronautical Information Service to Aeronautical Information Management.

**R&D**

Develop and validate common information exchange models (e.g. ATFCM, Meteo, flight data).

Develop and validate human factors principles for the exploitation and interpretation of the information being exchanged.

Develop and validate SWIM infrastructure and services through local prototypes to assess interoperability and performance aspects, including requirements for CNS technologies.

| SWIM Capability Level 2 Deployment |
|---|
| **Update Institutional Provisions**<br>• P2.I1 – Update institutional provisions based on P1 experience. |
| **Build Network / Connectivity (SWIM Capability Level 2)**<br>• P2.N1 – Implement high speed connectivity for all partners;<br>• P2.N2 – Implement mobile connectivity at all locations when needed. |
| **Expand Local SWIM Interoperability service**<br>• P2.S1 – Implement "Local SWIM Connectivity Service" in all partner systems. |
| **SWIM-enabled User Applications**<br>• P2.A1 - Timing of some applications in SWIM Capability Level 2 will depend on the ATM implementation schedule;<br>• P2.A.2 – Implement Controller tools to use *shared* 4D trajectory data;<br>• P2.A3 - Implement En-route ATC sub-systems to use *shared* RBT and PT and *share* constraints and clearances. |
| **R&D** |
| Validate use of aircraft derived data including weather data to enhance ground trajectory functions and safety nets.<br>Identify the detailed operational requirements for new airport Datalink.<br>Identify the detailed operational requirements for ADS-C and CPDCL to support European operation (e.g. Meteo and trajectory).<br>Define and validate the CDM processes and the communication mechanisms to enable participation of ATM performance partners in all phases of flight.<br>Develop and validate the visualisation tools covering all stakeholder information access and performance needs to operate NOP. |

| SWIM Capability Level 3 Deployment |
|---|
| **Handle Institutional Requirements**<br>• P3. I1 – By this time, all the institutional details concerning SWIM should be well established and functional. Eventual new requirements are handled as part of the routine operation.. |
| **Build Network / Connectivity (SWIM Capability Level 3)**<br>• P3.N1 – All the elements of the information network supporting SWIM must be in place with only the air/ground segment still not fully implemented everywhere. However, adding new nodes in the form of additional aircraft (or in fact any other user) is a routine operation. |
| **Expand Local SWIM Interoperability service**<br>• P3.S1 – Local SWIM Connectivity Service has been implemented in all existing systems (e.g. e.g. AGDLGMS on the ground side and corresponding Aircraft functionality) and all new systems contain this element as a baseline feature. Operating using the information network supporting SWIM is the normal mode for all systems. |
| **SWIM-enabled User Applications**<br>• P3.A1 - SWIM is now used to support even the most advanced ATM applications, even real time surveillance applications. It is ATM requirements that drive the implementation of the ATM applications with information management not forming a limitation of any kind. |
| **R&D** |
| None required |

## 3.2.2 Institutional Roadmaps

This section contains the roadmaps for the supporting aspects that will enable operational evolutions and stakeholder deployment plans. These activities have to be fully synchronised with the associated SWIM Capability Levels, ATM Service Levels and ATM Capability Levels.

### 3.2.1.1 Legislation/Regulation

This Legislation/Regulation roadmap covers the improvements with regards Legislation/Regulation to support the implementation of the ATM Target Concept. It also includes the Legislation/Regulation activities related to each of the other Supporting Activities.

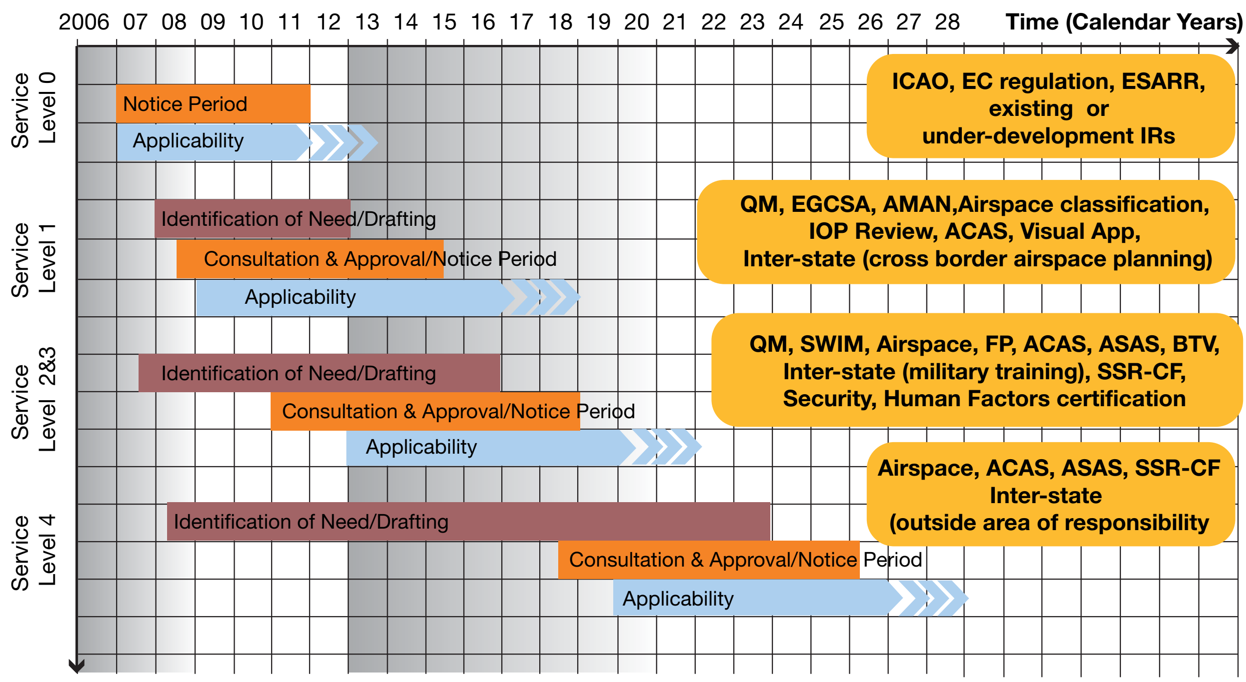



Figure 20: Legislation / Regulation roadmap



Issued by the SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL

| Service Level 0&1 |
|---|
| Continued development of current draft **EU legislative** proposals.<br>Publish revised Annex 1 of the **Interoperability Regulation** following review for compatibility with the SESAR Reference Architecture.<br>Develop and publish any further **EU legislation** required (following an identification of needs process) to address current safety regulatory shortcomings and to support the implementation of Operational Improvements, noting that it is unlikely that any proposals for new European legislation which is not already under development could be taken to publication in time for implementation before the end of Service Level 1 |
| Following "identification of needs" process, amend **national legislation** in response to new EU legislation. If required, where concept developments are not enforced through EU legislation, amend national legislation to support SESAR deployment.<br>Perform **regulatory oversight** on changes to the ATM system. Includes EASA certification of airborne equipment and NSA oversight and approval of ANS Providers/Airports. Appropriate standards (ICAO, EUROCONTROL, EUROCAE, ESO) would be an input into regulatory approval. |
| Publish **inter-state** agreements (cross border airspace planning). |
| **Identification of needs for Service Level 1** |
| Review Annex 1 of the Interoperability Regulation for compatibility with the SESAR Reference Architecture.<br>Investigate how to establish institutional, legal, financial and liability issues related to Meteo service provision.<br>A legislative and regulatory impact assessment in line with EC guidelines (SEC(2005)791) will be conducted, covering the full life cycle of all legislative proposals for Service Level 1. Such impact assessment will be used to consider and to balance the imperatives of Safety, Economic, Efficiency, and Environmental impacts in particular (along with the 11 ICAO KPAs) with synergies and trade-offs in a sustainability perspective and to facilitate decision-making/buy-in by all stakeholders at all stages.<br>ICAO and other proposed standards will be key inputs into this process. Initial screening suggests that legislative/regulatory actions are expected to be required for:<br>Queue Management **(QM)** (Extended AMAN, Synchronised DMAN, integrated AMAN/DMAN), **Interop (IOP) Regulation Annex A, Enhanced Ground Controller Situation Awareness (EGCSA)** in all weather conditions at airports and using Shared Trajectory, **Airspace** (below FL195). **ACAS** (ATSAW), **ASAS** (Manually controlled S&M), **Visual** contact **App**roaches for IFR traffic. |

| Service Level 2 |
|---|
| Develop and publish any further **EU legislation** required following the "identification of needs" process. |
| **National** activities as for Service Level 0/1. |
| Publish **inter-state** agreements (shared use of military training areas). |
| Operate the SESAR Safety Regulatory-Coordination Function **(SSR-CF)** for Service Level 2 in a clarified ATM safety regulatory framework and process, in cooperation with EASA. |
| Implement a **Security** regulatory framework. |
| Implement framework and process for **certification of Human Factors** of integrated air/ground systems, in cooperation with EASA. |
| **Identification of needs for Service Level 2** |
| Develop a framework and process for certification of integrated air/ground systems (including Human Factor Aspects), in support to EASA.<br>Update SWIM Institutional Provision based on previous service level experience.<br>Review the output of other R&D activities to determine any new potential legal implications (e.g. changing roles and responsibilities, such as those relating to ASAS applications and automated BTV).<br>Investigate options to change the economic regulatory framework to facilitate the use of incentives to support the implementation of OIs.<br>A legislative and regulatory impact assessment (including safety regulatory baseline and framework) in line with EC guidelines (SEC (2005)791) will be implemented and cover the full life cycle of all legislative proposals for Service Level 2. Such impact assessment will be used to consider and to balance the imperatives of Safety, Economic, Efficiency, and Environmental impacts in particular (along with the 11 ICAO KPAs) with synergies and trade-offs in a sustainability perspective and to facilitate decision-making/buy-in by all stakeholders at all stages.<br>Initial screening suggests that legislative/regulatory actions are currently expected to be required for:<br>Queue Management **(QM)** (multiple airport AMAN/DMAN, AMAN/SMAN, DMAN/SMAN, optimised DMAN, CTA), **SWIM** (Datalink services, Institutional framework: security, Governance and Access Rules), ASPA-S&M, **Airspace, Flight Plan (FP). ACAS** RA downlink, Brake To Vacate **(BTV)**.<br>Establish SSR-CF and define SESAR JU interface arrangements with SSR-CF, in support of the "identification of needs" process. Clarify responsibilities and accountabilities of the different stakeholders involved in safety regulation. |

| Service Level 3 |
| --- |
| Develop and publish any further **EU legislation** required following the "identification of needs" process |
| **National** activities as for Service Level 0/1 |
| Operate the SESAR Safety Regulatory-Coordination Function **(SSR-CF**) for Service Level 3 in a clarified ATM safety regulatory framework and process, consistent with EASA. |
| **Identification of needs for Service Level 3** |
| Review the output of other R&D activities to determine any new potential legal implications (e.g. changing roles and responsibilities, such as those relating to ASAS applications).<br>Investigate options to change the economic regulatory framework to facilitate the use of incentives to support the implementation of OIs.<br>A legislative and regulatory impact assessment (including safety regulatory baseline and framework) in line with EC guidelines (SEC (2005)791) will be implemented and cover the full life cycle of all legislative proposals for Service Level 3. Such impact assessment will be used to consider and to balance the imperatives of Safety, Economic, Efficiency, and Environmental impacts in particular (along with the 11 ICAO KPAs) with synergies and trade-offs in a sustainability perspective and to facilitate decision-making/buy-in by all stake-holders at all stages.<br>Initial screening suggests that legislative/regulatory actions are currently expected to be required for:<br>Queue Management **(QM)** (Multi-CTO), **ASAS** (ASEP-ITP).<br>Establish SSR-CF and define SESAR JU interface arrangements with SSR-CF, in support of the "identification of needs" process for service level 3. Clarify responsibilities and accountabilities of the different stakeholders involved in safety regulation. |

| Service Level 4 |
| --- |
| Develop and publish any further **EU legislation** required following the "identification of needs" process. |
| **National** activities as for Service Level 0/1. |
| Operate the SESAR Safety Regulatory-Coordination Function **(SSR-CF)** for Service Level 4 in a clarified ATM safety regulatory framework and process, consistent with EASA. |
| Publish **Inter-state** agreements (service provision outside area of responsibility). |
| **Identification of needs for Service Level 4** |
| Review the changing responsibility and liability issues associated with new ways of working (e.g. ASAS self separation).<br>Review the output of other R&D activities to determine any new potential legal implications.<br>A legislative and regulatory impact assessment (including safety regulatory baseline and framework) in line with EC guidelines (SEC(2005)791) will be implemented and cover the full life cycle of all legislative proposals for Service Level 4. Such impact assessment will be used to consider and to balance the imperatives of Safety, Economic, Efficiency, and Environmental impacts in particular (along with the 11 ICAO KPAs) with synergies and trade-offs in a sustainability perspective and to facilitate decision-making/buy-in by all stakeholders at all stages.<br>Initial screening suggests that legislative/regulatory actions are currently expected to be required for: **ASAS** (ASEP-C&P, ASEP WV spacing, Self separation, 4D contracts), **Airspace, ACAS** (new separation modes)<br>Establish SSR-CF for service level 4. Clarify responsibilities and accountabilities of the different stakeholders involved in safety regulation. |

### 3.2.2.2 Standardisation

This Standardisation roadmap covers the improvements with regards Standardisation to support the implementation of the ATM Target Concept. In order to ensure global interoperability the preparation of European standards will be done in cooperation with programmes from other regions of the world (such as NextGen), and also supports the development of standards taking into account military requirements.

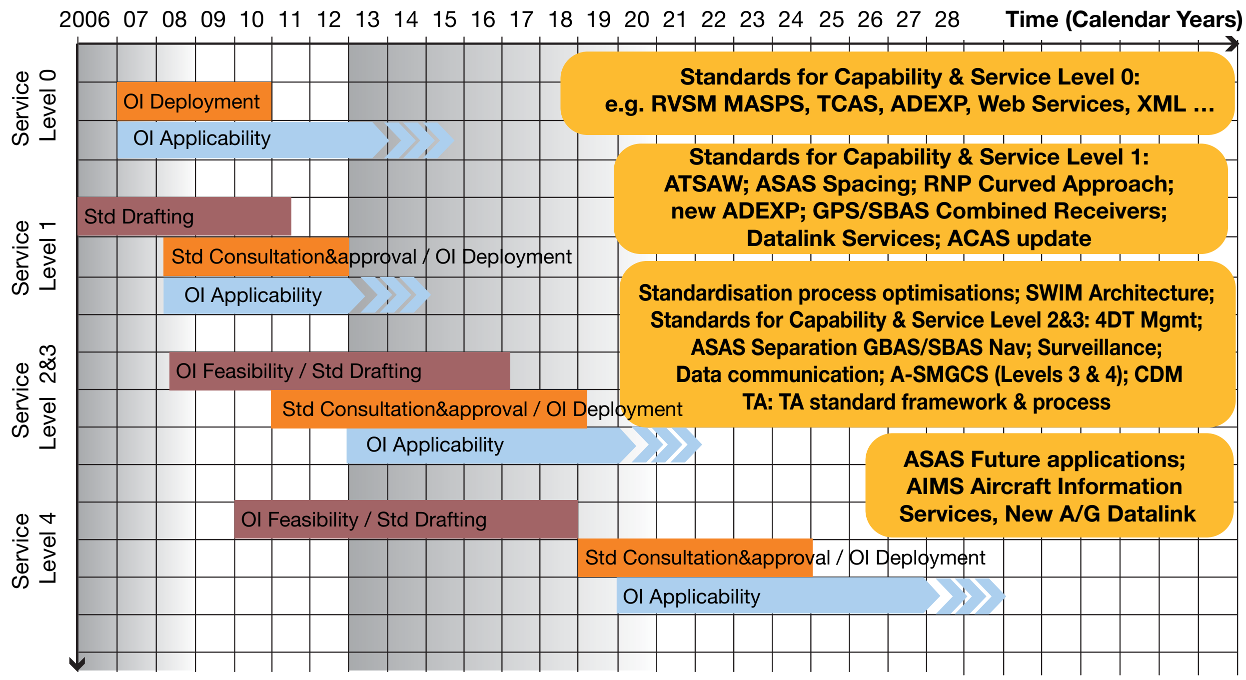



Figure 21: Standardisation roadmap

Note: OI Deployment and OI Applicability have been chosen to depict the period during which the standards will be deployed and applied through the OI that will make use of them.

| Service Level 0&1 |
|---|
| ICAO, EUROCONTROL and EUROCAE standards for **ATSAW** and **ASAS Spacing**; ICAO standards for **RNP curved approach; ADEXP** (Adaptation to new aircraft operator-ANS Provider flight plan data exchanges); Development of new standard for ground-ground interface with fight object; MOPS for **Galileo/GPS/SBAS combined receivers;** ICAO Manual, SARPs, IOP and SPR to support **Datalink services** (including Meteo) for PM-CPDLC, PM-ADS-C (needed as a pre-requisite for future applications) and FIS applications; **ACAS update** (MOPS v 7.1). <br> Use existing standards e.g. RVSM MASPS, TCAS, ADEXP, Web Services, XML, etc. |
| **Identification of needs for Service Level 1** |
| Derive requirements for ground-ground interface with flight object (flow and capacity management). <br> Evaluate the compatibility and consistency of the SESAR concept with ICAO and the subsequent necessary actions. |

| Service Level 2 |
|---|
| **Optimise** the **standardisation** development **process** by incentivising stakeholders participation and by suppressing the intermediate ESO (European Standardisation Organisation, namely CEN, CENELEC, ETSI) steps for technical Community Specifications (directly to EUROCAE). |
| Produce ICAO and EUROCAE standards for **GBAS/SBAS Navigation** (Revision of existing ICAO docs and development of new MASPS/MOPS to cover signal specification, precision approach operations and ground subsystem; also standards required for Airborne HUD/EVS system); **Surveillance** (airborne detection systems); **Architecture and SWIM** (System interfaces, SWIM architecture, ATM, Aerodrome ATC system technical architectures); **A-SMGCS (Levels 3 & 4); CDM** (complete work for Airport-CDM and develop new standard for User Decision Prioritisation Process CDM), VoIP (radio). <br> The current timetable for service level 2 operations requires deployment of some OI Steps before standardisation activities can be completed. The Standardisation process will have to be accelerated (additional resource and optimisation) or the OI Step delayed. |
| Implement Supporting Area **standardisation framework & process**. |
| **Identification of needs for Service Level 2** |
| Derive requirements for ASAS separation; derive safety, performance and interoperability requirements for 4D-Trajectory Management; derive performance requirements for airborne HUD/EVS system; R&D related to SWIM concept development and related architectures; operational concept development for A-SMGCS (levels 3 and 4) and UDPP CDM. <br> Derive requirements for VoIP (radio). <br> Develop an optimised standardisation process (stakeholder participation, CS selection process, CS assignment, complexity); Develop an ATM Supporting Area standardisation framework and process. <br> Evaluate the compatibility and consistency of the SESAR concept with ICAO and the subsequent necessary actions. |

| Service Level 3 |
|---|
| Produce ICAO and EUROCAE standards for **ASAS Separation** and **4DT Management; Surveillance** (ADS-B-ADD, Wake Vortex detection and safety net alerts), **Data communication** (Ground and Satellite based communication co-ordinated through ICAO ACP); IP network and new airport WIMAX surface Datalink. <br> The current timetable for service level 3 operations requires deployment of some OI Steps before standardisation activities can be completed. The Standardisation process will have to be accelerated (additional resource and optimisation) or the OI Step delayed. |
| **Identification of needs for Service Level 3** |
| Derive requirements for ASAS separation; derive safety, performance and interoperability requirements for 4D-Trajectory Management and ADS-B-ADD; feasibility and performance requirements for wake vortex detection systems; ICAO ACP co-ordinated R&D activities related to air-ground communication. <br> Derive requirements for IP network and New airport WIMAX surface Datalink. <br> Evaluate the compatibility and consistency of the SESAR concept with ICAO and the subsequent necessary actions. |

| Service Level 4 |
|---|
| Produce ICAO and EUROCAE standards for **future ASAS applications** (based on new Datalink standards and air-air exchange of data); Exchange of **aircraft** derived **Aeronautical Information** compatible with aircraft open format (e.g. NDBX) and new Air-Ground Datalink Technologies. |
| **Identification of needs for Service Level 4** |
| Derive requirements for future ASAS applications and new Air-Ground Datalink Technologies; derive requirements for Airport and Terrain Mapping and Obstacle Information. <br> Monitor the compatibility and consistency of the SESAR concept with ICAO and subsequently launch the necessary actions. |

## 3.2.3 Integrated Management System Roadmaps

### 3.2.3.1 Safety

This Safety roadmap covers the improvements to be implemented for the management of Safety aspects of SESAR and to support the implementation of the ATM Target Concept.

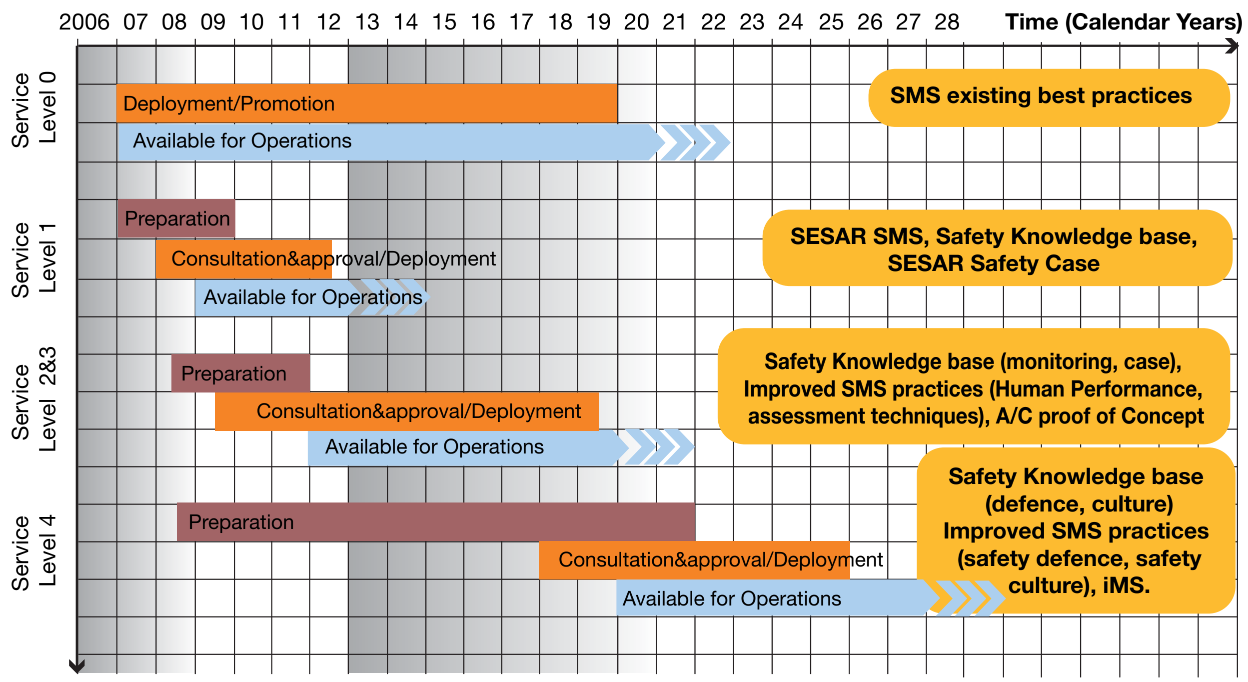



Figure 22: Safety roadmap

| Service Level 0&1 |
|---|
| Further implement **existing SMS best practices:** Apply the SMS Processes building on ESP (European Safety Programme) achievements/foundation to provide for safety achievement, develop safety assurance (e.g., safety surveys and internal audits), promote and communicate the safety results and where required obtain safety approvals (certification) and launch safety improvement initiatives. Improve approved SMS practices for Service Level 1 (new models, human factors, SMS interfaces). |
| Establish SESAR **SMS**. |
| Set-up a **SESAR Safety Case** within SESAR SMS framework (as per approved SESAR SMP (Safety Management Plan)) to allowing a true and effective real-time management of safety throughout the SESAR Development and Deployment phases: integrate ongoing safety cases for individual OI Steps and initiate monitoring of safety performances. |
| Set-up and maintain the SESAR **Safety Knowledge base** (based on skybrary) to support the safety management process. |
| **Service Level 0&1 Preparation** |
| Harmonise the interfaces of Management Systems of ATM Provider, airport and airspace users.<br>Develop new models (e.g. top-down accident-incident model, Safety Target Achievement Roadmap (STAR), true separation assurance, and Barrier Safety Model for Airports).<br>Further develop safety assessment techniques (e.g. identification of future and 'emergent' risks (related to hazards that have not yet been seen in ATM), the success approach part of safety assessment and safety case development).<br>Develop techniques for human factors in safety assessment (e.g. Refine Human Reliability Assessment (HRA) techniques, complete Human Assurance Levels (HALs), a complete, homogeneous and holistic view for integrating human factors in safety assessments and safety case development).<br>Develop an Alerting Philosophy for e.g. design of HMI to cope with increased introduction of a number of new displays and associated alarms within SESAR ATM Target Concept. |
| **Service Level 0&1 Enablers** |
| Automatic Safety Data Gathering.<br>Safety Register Management Tool.<br>Safety Monitoring Means adapted to SESAR. |

| Service Level 2&3 |
|---|
| Update and maintain the SESAR **Safety Knowledge base** (add: Safety monitoring, Safety Case) to support safety management process. |
| Implement improved and approved **SMS practices** (safety monitoring, safety culture, policies on integration of safety nets in system safety design). |
| Apply the principle of 'proof of Concept' for Aircraft certification. |
| **Service Level 2&3 Preparation** |
| Develop risk migration theory and models (e.g. a phenomenon known as 'risk migration', such that risk is 'off-loaded' to other parts of the ATM system, or another operational centre, or even to another transport medium (e.g. rail) in case of critical events).<br>Develop Resilience Engineering and layered safety defences Paradigms.<br>Investigate Safety Intelligence paradigm which aims to ensure that safety motivation can be most effectively channelled at all levels in the organisation.<br>Develop a complexity-safety model (when complexity becomes unsafe) and 'de-complexifying' ways of displaying information to controllers.<br>Develop more advanced tools, such as computer simulation models, Dynamic Simulation Modelling and Cognitive Modelling, increasing the Granularity of Safety Modelling (Dynamic & Cognitive Risk Modelling).<br>Develop Human Performance Envelop Modelling.<br>Develop the principle of 'proof of Concept' for Aircraft certification. |
| **Service Level 2&3 Enablers** |
| Global safety monitoring system.<br>Recognised Acceptable Means of Compliance, when required. |

| Service Level 4 |
|---|
| Develop and maintain the SESAR **Safety Knowledge base** (add: Safety defence, Safety Culture) to support the safety management process. |
| Improve approved **SMS** practices (safety defence, safety culture). |
| Implement **iMS** (Integrate Safety Management in the integrated Management System (iMS)). |
| **Service Level 4 Preparation** |
| Undertake innovative research focussing on 'safety-driven' concepts and a fully integrated architecture of safety defences – a safety defence network – for all phases of flight including surface operations.<br>Develop appropriate framework (processes, practices and tools) for an integrated Management System (iMS) that will reconcile safety, security, environment and human performance management systems and contingency. Initial validation of iMS. |
| **Service Level 4 Enablers** |
| Safety Culture adapted to new context.<br>Recognised Acceptable Means of Compliance, when required. |

### 3.2.3.2 Security

This Security roadmap covers the improvements to be implemented for the management of Security aspects of SESAR and to support the implementation of the ATM Target Concept.

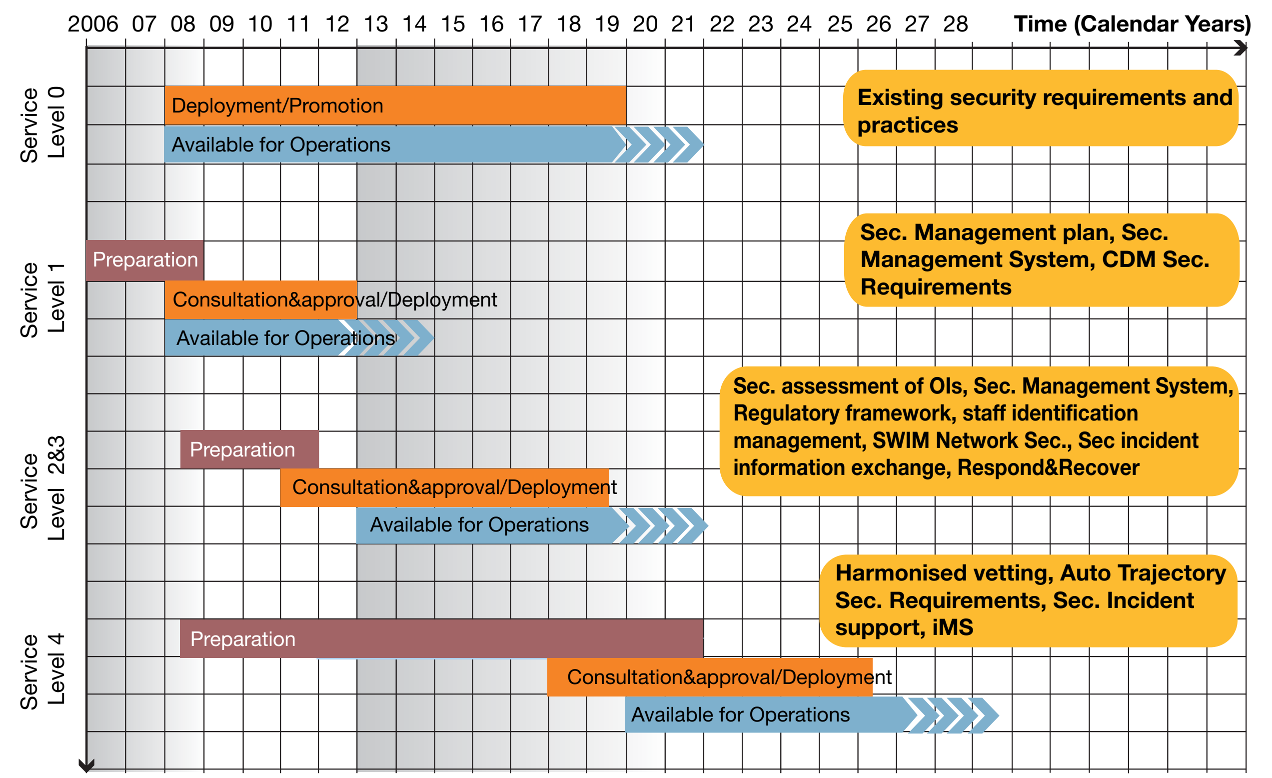



Figure 23: Security roadmap

| Service Level 0&1 |
| --- |
| Implement the **Security Management Framework and Plan**. Foundation documents are a Security Plan, the Security Policy and Security Management Organisation. |
| **Service Level 0&1 Preparation** |
| Develop an ATM Security Framework and Plan.<br>Develop proposal for security governance in Europe.<br>Develop and validate security Compliance Framework for security validation.<br>Develop and validate Security Performance Metrics for performance assessment. |

| Service Level 2&3 |
| --- |
| Perform **Security Assessment of Operations and Stakeholder systems** including SWIM and CDM. |
| Implement SESAR **Security Management System (SecMS).** This is for an enhanced SecMS that must be implemented by all states in a consistent way. |
| Implement an **International Regulatory framework** (ICAO, EU, National) to support full operation of the SESAR ATM Target Concept. |
| Implement harmonised **staff Identification** management in Europe. |
| Implement the **security incident information exchange** to provide assistance concerning incidents that could be of assistance to other ANS Providers or governments. |
| Implement the **Respond and Recover** capability. To define the requirements for response and recovery after a security incident in order to restore the ATM service and to see them incorporated in SESAR facilities. |
| **Service Level 2 &3 Preparation** |
| Define and validate a Security Risk Assessment and Planning.<br>Develop and validate method and tools to support security assessment.<br>Define and validate standards for Staff Identification.<br>Develop and validate a Security Incident Information Exchange.<br>Develop and validate Incident Support.<br>Define and validate Respond and Recover process.<br>Develop and validate standards for assurance of Data Confidentiality Level.<br>Define and validate requirements for accountability for information and authentication.<br>Define collaborative support for sharing real time alerting and threat information. |

| Service Level 4 |
| --- |
| Apply a harmonised process for **vetting** of staff, accepted throughout Europe. |
| Integrate **Auto Trajectory** Security Requirements in order for SESAR ATM Target Concept to be able to operate as proposed. |
| Implement methods and means to support government agencies for the management of **security incidents** within a state and across borders. |
| Implement **iMS** (Integrate Security Management System in (iMS)). |
| **Service Level 4 Preparation** |
| Develop a Security Management Policy/Strategy<br>Develop methods and tools to support Auto Trajectory security assessment<br>Develop ATM Security Regulation at ICAO and European level taking into consideration Best Practices.<br>Develop and produce standards for Access and Vetting to support ATM Security Operations/Security Service |

### 3.2.3.3 Environment

This Environmental Sustainability roadmap covers the improvements to be implemented for the management of environmental aspects of SESAR and to support the implementation of the ATM Target Concept. The related operational environmental benefits are covered through ATM Service Level and Capability Level in Chapter 3.1 and 3.3 as appropriate.

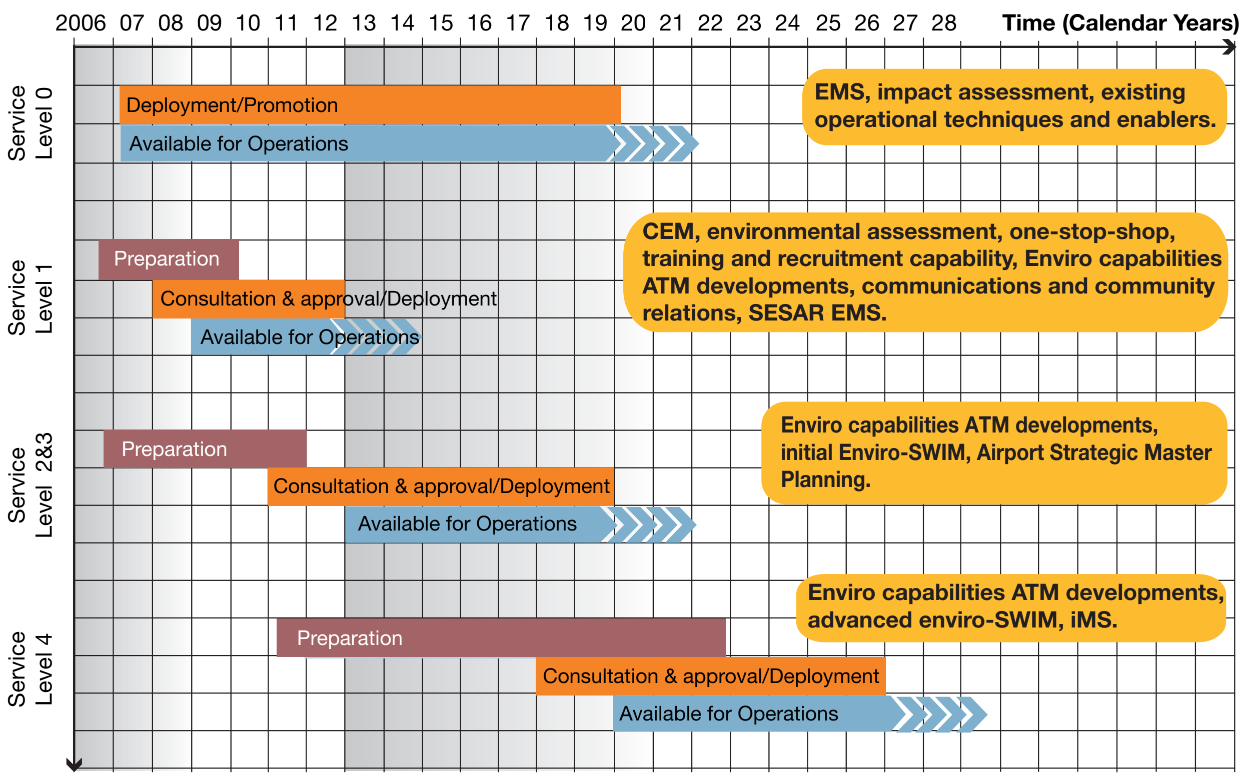



Figure 24: Environment roadmap

| Service Level 0&1 |
|---|
| Further implement **existing EMS (Environment Management System) best practices:** Move towards a sustainability scope for ATM decision making; increase ability to assess and take account of socio-enviro economic impacts of ATM; with a commonly agreed strategy for ongoing development. |
| Perform transparent socio-enviro-economic **impact assessment** for all key ATM decisions to ensure that unnecessary or non-optimal environmental constraints and practices are avoided. |
| Widespread of Collaborative Environmental Management **(CEM)** supported by individual stakeholders environmental managements systems (to the quality of ISO14001/EMASII). |
| Apply commonly agreed, increasingly advanced and useable **environmental sustainability assessment** and validation methodologies and tools. |
| Ensure a widely used and commonly agreed '**one-stop-shop**' for environmental sustainability guidance and support resources such as guidance notes, checklists, case-studies, benchmarking facilities and information repositories. |
| Ensure adequately a suitably **trained and aware workforce** (including specifically qualified expertise) with a strategy for ongoing achievement into the future. |
| Maximise the recognition and the use made of the **environmental capabilities of Service Level 0&1 developments,** while also developing specific environmental techniques, procedures and capabilities. |
| Implement more effective **two-way community relations and communications** capabilities at local & regional levels (e.g. web portal), including a commonly agreed environmental sustainability lexicon. |
| Establish SESAR EMS (Environment Management System) that will also ensure adequate performance management capability to ensure good ATM decision-making (both within iMS and generally): Framework (e.g. commonly agreed policy, targets and KPIs etc); Communications channels and (e.g. transparent reporting via the web); Information (i.e. models, tools, operational data, modelling results, etc). |
| **Service Level 0&1 Preparation** |
| Develop or adopt commonly endorsed: Impact Assessment methods and ATM decision support tools, environmental sustainability lexicon and one-stop-shop.<br>Develop ATM's understanding of it aspects, effects and impacts in a socio-enviro-economic scope.<br>Develop Collaborative Environmental Management (CEM) and Environmental Management Systems (EMS) implementation support resources.<br>Develop best practice based guidance on airport strategic master planning - integration with land-use planning and possible supervisory instruments.<br>Develop training and awareness resources to support the environmental sustainability skill needs for ATM.<br>Develop targets KPIs, impact metrics and depiction/reporting methods to allow ATM to adequately manage its performance and to assess and communicate this with interested parties (including the public). |

| Service Level 2&3 |
|---|
| Exploit/maximise **environmental sustainability capabilities/performance** of Service Level 2&3 developments and develop more advanced environment specific techniques capable of tailoring the impact around airports. |
| Publish Environmental Sustainability information into **SWIM** and vice versa i.e. to allow environmental parameters to be included in ATM decision-making and the use of operational parameters in environmental sustainability performance management. |
| Provide a framework for the planning for more sustainable **airport** growth through widespread adoption and publication of airport **strategic master plans** that are fully integrated with local land-use plans and policies. |
| **Service Level 2 &3 Preparation** |
| Understand and develop response to any risks to aircraft operations from any predicted effects of climate change itself.<br>Contribute proactively to increasing the scientific certainty of aviation impacts in the En-Route phase and in particular the upper atmosphere (e.g. contrail cirrus) to ensure sound policy (global and European) - developing mitigation options and monitor the policy response.<br>Develop and endorse more advanced environmental sustainability assessment capabilities (models and algorithms etc) including interdependencies supporting international efforts in this area and developing tools for European use. |

| Service Level 4 |
|---|
| Exploit/maximise **environmental capabilities of Service Level 4 developments.** |
| Implement **Advanced Enviro-SWIM** (Environment information published into SWIM). |
| Implement **iMS** (Integrate Environment Management System in (iMS)). |
| **Service Level 4 Preparation** |
| Develop a commonly endorsed strategy for planning, developing and operating the European ATM system as an integral part of the European (and global) intermodal mobility system.<br>Contribute proactively to increasing the scientific certainty of aviation impacts in the En-Route phase and in particular the upper atmosphere (e.g. contrail cirrus) to ensure sound policy (global and European) - validate existing theories, developing mitigation options and monitor the policy response. |

### 3.2.3.4 Human Performance

This Human Performance roadmap covers the improvements to be implemented for the Human Factors (HF), Recruitment, Training, Competence and Staffing (RTCS) and Social Factor and Change Management (SFCM) aspects of SESAR and to support the implementation of the ATM Target Concept.

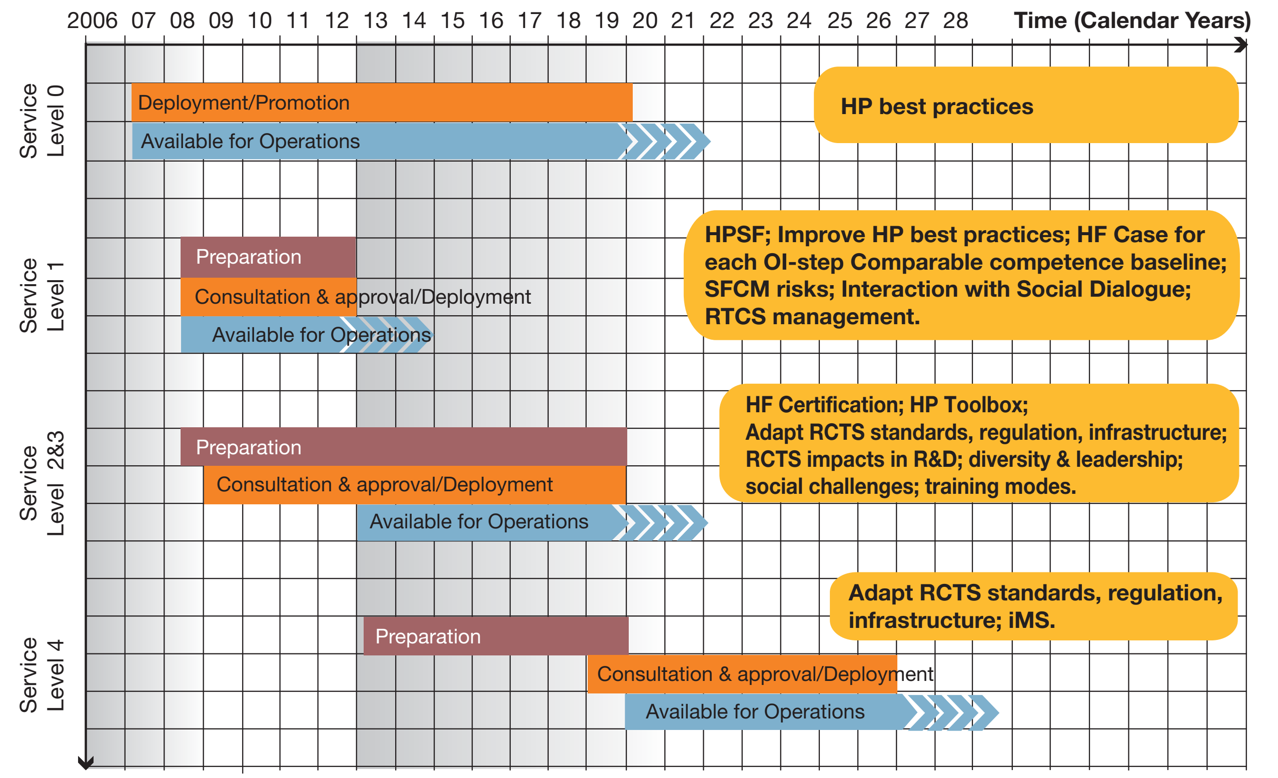



Figure 25: Human Performance roadmap

| Service Level 0&1 |
|---|
| Further implement existing best practices in Human Performance Management in ATM across Europe. Improve implementation of **Human Performance best practices** for Service Level 1. |
| Establish and maintain **Human Performance Steering Function (HPSF)** to ensure that all human performance aspects are systematically and consistently managed throughout SESAR. |
| Improve implementation of **Human Performance best practices.** |
| Carry out **Human Factor Case** to timely and systematically identify, prioritise and manage human performance issues, for all Service Levels. |
| Establish a **comparable competence baseline** for all European ATM operational staff to enable implementation of harmonised systems and procedures in all areas of the ATM system (e.g. ATCOs, ATSEPs). |
| Assess and manage social factors and change management **(SFCM) risks** for all Service Levels. |
| Manage **interaction** between Master Plan activities and EU Sectorial **Social Dialogue** Committee for Civil Aviation. |
| Foster pro-active **management** of Recruitment, Training, Competence and Staffing **(RTCS)** activities at industry level in support of all Service Levels, including training delivery, trace and adapt staffing levels according to implications of SESAR deployment activities (staffing needs for operations, upgrade and continuation training and user involvement in system design). |
| **Service Level 0&1 Preparation** |
| Human Factor related preparation<br>- Further develop and validate HF Case methodology including guidance and training material.<br>- Develop plan to improve implementation of human performance best practices.<br>Recruitment, Training, Competence and Staffing related preparation<br>- Develop enhanced comparability of operational competence through new and refined standards.<br>- Develop training and competence standards and infrastructure to prepare operational staff for implementation of Service Levels 1 improvement steps (ca. 6.4 Mio training days for ca. 500.000 operational aviation staff expected across Europe).<br>- Define safety criticality of Human tasks and a rationale for the degree of regulation for training and competence.<br>Social Factor and Changes Management related preparation<br>- Develop guidelines and tools for systematic change management and its social consequences.<br>- Develop monitoring and analysis tools to assess Social and Change risks. |

| Service Level 2&3 |
|---|
| Conduct **Human Factors certification** as part of overall certification processes. |
| Common use of **toolbox** of generic **Human Performance** methods and techniques. |
| **Adapt** international/national and local **RCTS standards, regulations and infrastructure.** |
| Identify **RTCS in all SESAR R&D** related to all operational improvement steps. |
| Manage cultural and organisational **diversity** and enhance **leadership** competence. |
| Manage future **social challenges** and enhance changes processes via new forms of industrial relations. |
| Introduce new **training modes** to prepare for enhanced information sharing and CDM processes (interdisciplinary training) and for increasing automation (refresher training for ground roles for non-standard situations). |
| **Service Level 2&3 Preparation** |
| Human Factor related preparation<br>- Develop and validate top-down SESAR functions analysis, including development of automation classification scheme and automation (failure) strategies.<br>- Define new roles and responsibilities for future staff.<br>- Optimise trade-off between advance planning and the necessary flexibility of SESAR system dealing with unexpected events or degraded modes.<br>Recruitment, Training, Competence and Staffing related preparation<br>- Systematic examination of RTCS impacts in all SESAR R&D supported by standard methodology.<br>- Develop interdisciplinary training processes for enhanced CDM and network management.<br>- Develop a classification of simulation tools for ATM training oriented along SESAR capability levels.<br>- Develop training and competence standards and infrastructure to prepare operational staff for implementation of Service Level 2&3 improvement steps (ca. Mio 9.6 training days expected across Europe).<br>- Develop training simulation standards and certification aligned to SESAR capability levels. |

| |
|---|
| Social Factor and Changes Management relate preparation<br>- Develop processes and models to enhance participation of affected personnel.<br>- Develop a framework for enhanced leadership and management. |

| Service Level 4 |
|---|
| **Adapt** international/national and local **RCTS standards, regulations and infrastructure**. |
| Develop and deliver training to prepare operational staff for implementation of Service Level 4 improvement steps (ca. 8.2 Mio training days for ca. 500.000 operational aviation staff expected across Europe). |
| Trace and adapt staffing levels according to implications of SESAR deployment activities (staffing needs for operations, upgrade and continuation training and user involvement in system design). |
| Implement **iMS** (Integrate all Human Performance aspects in the integrated Management System (iMS)). |
| **Service Level 4 Preparation** |
| Human Factor related preparation<br>- Define appropriate mechanisms for task delegation and authority sharing.<br>Recruitment, Training, Competence and Staffing related preparation<br>- Develop enhanced competence schemes for operational ATM staff in highly automated environments.<br>- Timely examination of quantitative staffing impacts of very advanced systems and procedures.<br>- Develop training and competence standards and infrastructure suiting Service Level 4. Develop refined interdisciplinary and refresher training processes for very advanced procedures and role allocation for enhanced CDM and Network Management.<br>Social Factor and Changes Management related preparation<br>- Develop a framework for transferability and mobility of Civil Aviation staff.<br>- Develop common objectives in social policies for Civil Aviation.<br>- Develop a framework for future social challenges & change management. |

#### 3.2.3.5 Contingency planning for ANS/Airport deployment activities

Two aspects of contingency[8] have to be considered:
- The capability of ANS Providers/Airports to deal with emergency situations and/or degraded modes of operations and to ensure orderly and efficient transition from normal to emergency operations, and return to normal operations ("emergency preparedness");
- The capability of ANS Providers/Airports through suitable arrangements to provide alternate ANS/Airport services of an agreed quality of service to be readily activated when a long-term disruption of normal service provision is anticipated or after disruption of ATS and related support services ("Service continuity capability").

During the Service Level development/transfer to Operations and operations phases, there will be two kinds of contingency impact assessment:
- A generic one ("Generic Contingency case") prior to the deployment of the Service Level;
- Local or regional one ("Contingency plan") prior to transfer of operation and operations.

The "System" contingency related aspects to be considered are "Architecture" and "Technologies":
- CNS Technologies should be assessed as early as possible – as part of the "Feasibility study"- and no later than before "Industrialisation";
- Architecture of the system should be assessed for contingency prior to its deployment.

Contingency planning covers also various aspects such as security, human performance and procedures.

R&D is required for the ATM Service Levels 2-4 to develop and validate assessment methods to cover contingency aspects such as human system interactions, service continuity capability and emergency preparedness.

[8] According to the EC Regulation Common Requirements (CR) 2096/2005 of December 2005 regulation, Annex I, § 8.2, air navigation service providers "*... shall have in place contingency plans for all the services it provides in the case of events which result in the significant degradation or interruption of its services*".

## 3.3 Stakeholder Deployment Roadmap

This section contains the roadmaps for the Stakeholder investments, i.e. the progressive introduction of increasing ATM Capability Levels. The full spectrum of Stakeholder systems and infrastructure has been subdivided into 9 categories. Each System category has one roadmap that shows required R&D and deployment implementation within each of the ATM Capability Levels.

**It must be noted that these roadmaps require a careful integration and coordination to deliver the appropriate ATM Service Level on time. Synchronisation of air and ground activities and system roadmaps is of particular importance to mitigate stakeholders' investments.**

SWIM has not been included in these stakeholder roadmaps because it is applicable to all stakeholders. The necessary changes for SWIM are described in section 3.2.1, except for SWIM supervision as explained in the introduction of Chapter 3.

### 3.3.1 Users (Aircraft Operators) – Aircraft

#### 3.3.1.1 USER Transport aircraft

This enabler roadmap covers air transport category aircraft as used by Commercial Airlines, (including Legacy Airlines, Low Fare airlines, Regional Airlines), and by Business Aviation.

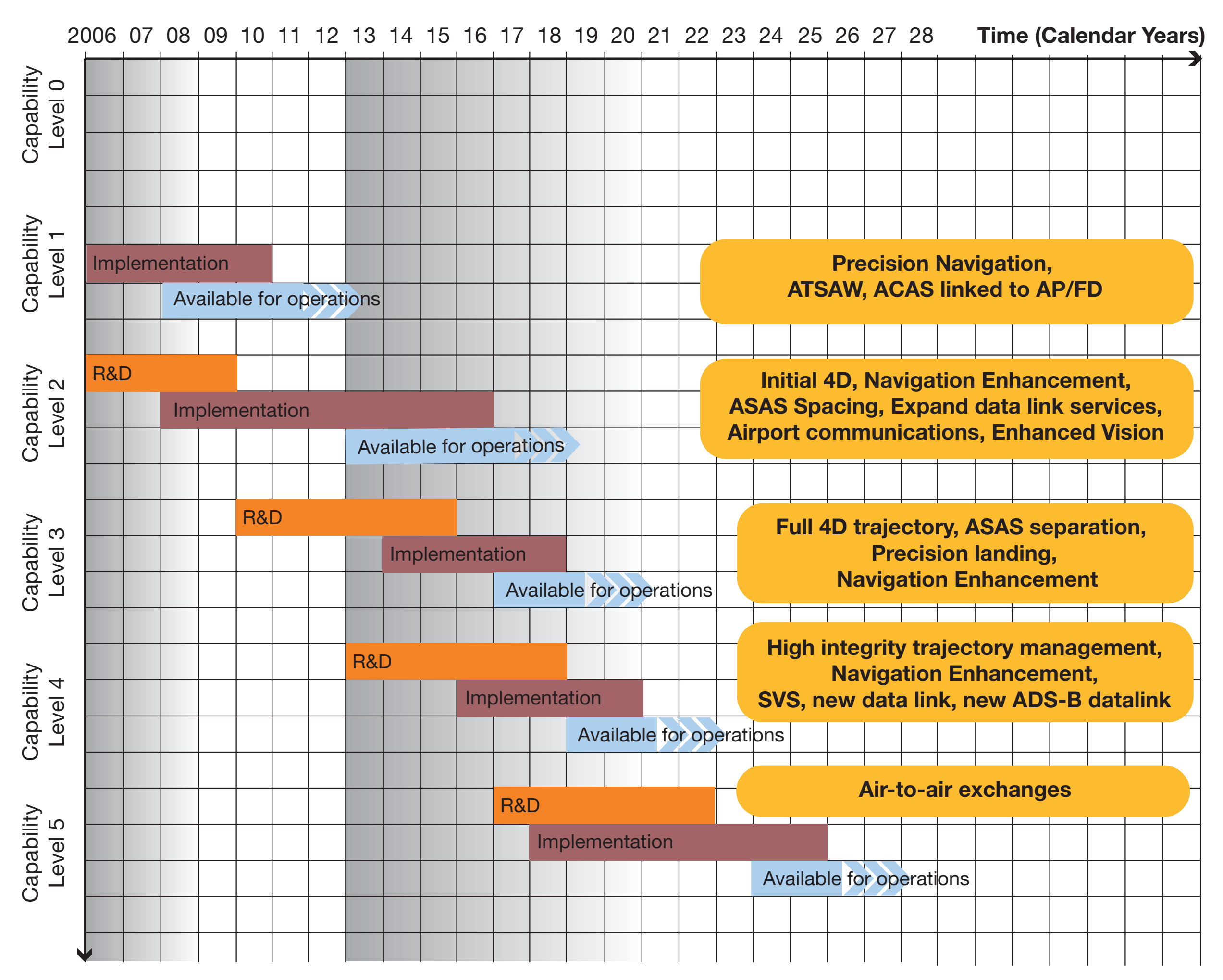



Figure 26: Users Transport Aircraft – Aircraft roadmap

| Capability Level 0 Deployment |
| --- |
| **Basic air-ground Datalink services:** Deploy Datalink services complementing voice communications (but not replacing them) and comprising the message sets supporting a wide variety of existing applications in the short-term period. |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **Precision Navigation:** implement Flight Management and flight deck evolution to support 2D-RNP, steep and curved Approaches, CDA/CCD and use of auto throttle to reduce noise; Cruise Climb modes for use en-route to allow climb as weight is reduced; in addition; implement baro-vnav or SBAS to support precision approaches (such as APV/Baro-VNAV, LPV or RNP AR) with vertical guidance for aircraft regularly operating on secondary airport (not ILS equipped). | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#5 Managing Business Trajectories in Real Time<br>LoC#10 Airport Throughput, Safety and Environment |
| **ATSAW:** Update Mode S transponder to support the implementation of **1090 ADS-B OUT** for air broadcast of aircraft position/vector. Update the traffic computer and display surrounding traffic on a moving map to support the implementation of **1090 ADS-B IN** to receive other aircraft position/vector. This enablers the implementation of ATSAW-AIRB, ITP, VSA and SURF applications. | LoC#8 New Separation Modes<br>LoC#10 Airport Throughput, Safety and Environment |
| **ACAS linked to AP/FD:** deploy upgrade of the ACAS to provide vertical speed guidance through autopilot or flight director display in case of resolution advisory. | LoC#9 Independent Cooperative Ground and Airborne Safety Nets |
| **Secure CPDLC:** Deploy secure CPDLC Datalink services complementing voice communi-cations (but not replacing them). | LoC#1 Information Management |
| **Capability Level 1 required R&D** | |
| Completed. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Initial 4D:** Update Flight Management and Flight deck to support the implementation of<br>• Controlled Time of Arrival (CTA) – time constraint on a defined merging point associated to an arrival runway;<br>• Precision Trajectory Clearances (PTC-2D), and Trajectory Control by Ground Based Speed Adjustment;<br>• Uplink of ATC constraints and downlink of 4D data. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#5 Managing Business Trajectories in Real Time<br>LoC#7 Queue Management Tools<br>LoC#8 New Separation Modes |
| **Navigation enhancement:** dual constellation receiver, ABAS. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **ASAS Spacing:** update Traffic Computer and Flight Management to manage New sepa-ration modes (ASAS S&M). | LoC#8 New Separation Modes |
| **Expand Datalink services:** update Datalink communication system to process uplink of Datalink clearances for taxi route, ASAS, Brake To Vacate, and AIS/Meteo data, as well as uplink/downlink of Meteo data. | LoC#8 New Separation Modes<br>LoC#10 Airport Throughput, Safety and Environment |
| **Airport Communications:** introduce new airport wireless Datalink (802.16 based) capa-bility. | LoC#10 Airport Throughput, Safety and Environment |
| **EVS:** Enhanced vision (EV) of terrain and runway on head up display (HUD) in Low Visibility Conditions to facilitate approach and ground operations. | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 2 required R&D** | |
| Develop and validate clear language, type of service, services data and security levels required for cooperative ground-air exchanges related to 4D trajectory (including weather data). Study interoperability with military Datalinks.<br>Develop and validate the techniques to improve the accuracy of positioning on airport surface also reliability of obstacle detection.<br>Update ABAS system to take on-board new GNSS capability to improve current IRS and GNSS performance.<br>By 2011, investigate, design, prototype airborne GNSS receiver capabilities. Develop and validate the air and ground components tech-nical specifications. As necessary, develop further R&D on Airborne receiver to exploit the enhancement of the Galileo integrity mechanism (dependent on a key political decision needed before 2011 on the Galileo Integrity Mechanism: Galileo Solution or other solutions like SBAS).<br>Develop and validate flight management and flight deck capabilities to support ASAS spacing applications.<br>Develop and validate 802.16 based Airport Datalink.<br>Develop and validate EVS architecture to provide precision approaches and taxi. | |

| Capability Level 3 Deployment | Supports Line of Change |
| --- | --- |
| **Full 4D Trajectory:** Update Flight Management and Datalink communication through:<br>• data sharing;<br>• ground broadcast of Uplink of AIMS/Meteo data (wind grids);<br>• auto taxi (optimising speed adjustment according to the cleared taxi route) and auto brake (making it impossible for an aircraft to cross a lit stop bar) to support automatic prevention of runway incursion;<br>• Multiple Controlled Times of OverFly (CTOs, in addition to CTA): time constraint management on several point of the trajectory. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#7 Queue Management Tools<br>LoC#8 New Separation Modes |
| **ASAS Separation:** update ADS-B 1090 receivers and flight deck to support ASAS separation applications such as ASEP-ITP (In Trail Procedure), as more advanced Airborne Separation mode where the role of separator is temporarily delegated to aircrew to maintain airborne separation. | LoC#8 New Separation Modes |
| **Precision landing:** introduce GBAS Cat III for landing and exploit technology for sub-metric surface movement positioning. | LoC#10 Airport Throughput, Safety and Environment |
| **Navigation Enhancement:** implement improved vertical navigation to fly pre-defined route 3D-PTC. | LoC#2 Moving from Airspace to Trajectory Based Operations |

| Capability Level 3 Required R&D |
| --- |
| Develop and validate the flight management processing of CTAs and multiple CTOs.<br>Develop and validate the automated avoidance trajectory proposal functions for ASAS ASEP ITP (In Trail Procedure). Analyse the interaction between ACAS algorithms and new separation modes.<br>Develop and validate the required performance of ADS-B receivers to support ASEP operations.<br>Develop and validate GBAS Cat III for precision landing; exploit infrastructure for high precision surface navigation and guidance.<br>Develop and validate architecture and performance requirements for Enhance Visual operations. |

| Capability Level 4 Deployment | Supports Line of Change |
| --- | --- |
| **High integrity trajectory management:** Update Flight Management, Datalink communication and flight deck to provide high integrity trajectory management and separation through data sharing, including management of TMR. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#8 New Separation Modes |
| **ASEP-C&P:** ASAS separation applications such as Crossing & Passing as more advanced Airborne Separation mode where the role of separator is temporarily delegated to aircrew to maintain airborne separation | LoC#8 New Separation Modes |
| **Navigation Enhancement:** Implement improved vertical navigation (VRNP) to fly "user preferred" 3D-PTC. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **SVS:** implement Synthetic Vision (SV) to improve approach and ground operations in Low Visibility Conditions. | LoC#10 Airport Throughput, Safety and Environment |
| **New Datalink:** deploy new L Band terrestrial Datalink and Satellite Based communication complement both using common internet working mechanisms. | LoC#1 Information Management |
| **New ADS-B Datalink:** deploy new ADS-B system as complement to ADS-B 1090. | LoC#8 New Separation Modes |

| Capability Level 4 required R&D |
| --- |
| Investigate the conformity of military aircraft with vertical performance navigation requirements.<br>Develop and validate the automated avoidance trajectory proposal functions for ASAS C&P (Crossing and Passing). Analyse the interaction between ACAS algorithms and new separation modes.<br>Develop and validate architecture to integrate wake vortex detection with ASAS applications.<br>Develop algorithms for detection and resolution of conflicts to support ASAS SSEP (including interaction with the predicted flight plan), leading to operational standards and performance requirements (including integrity for the flight management and predicted trajectory function). |

| |
|---|
| Develop and validate architecture and performance requirements for Synthetic Visual operations,<br>Assess the potential of infrared LED airport lighting to support ground surface operations.<br>Develop and validate requirements for new Datalink. Validate feasibility based on L Band terrestrial Datalink and Satellite Based communication.<br>Develop rules and methods to automatically publish (downlink) Predicted Trajectories (PT) with Trajectory Management Requirement (TMR). |

| Capability Level 5 Deployment | Supports Line of Change |
|---|---|
| **Air-to-Air Exchanges:** implement air-to-air exchanges to support:<br>• New Airborne Separation Modes (ASAS Self Separation);<br>• Wake Vortex (WV) free approach, where the spacing on the runway is adjusted dynamically based on the actual strength of the vortex of the predecessor, detected by on-board sensors,<br>• Air broadcast of weather hazards. | LoC#1 Information Management<br>LoC#8 New Separation Modes |
| **4D-PTC:** 4D-PTC processing that prescribes the containment of the trajectory in all 4 dimensions for the period of the contract and implement improved longitudinal navigation to support 4D-PTC. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **ASAS Self Separation:** Deploy new air broadcast and reception of trajectory data and new onboard conflict detection and resolution functions to support the delegation of the separation with all other aircraft. | LoC#8 New Separation Modes |
| **Capability Level 5 required R&D** | |
| Define requirements, develop and validate air-air point-to-point communications architecture.<br>Develop and validate architecture to integrate wake vortex detection with ASAS applications.<br>Develop algorithms for detection and resolution of conflicts to support ASAS SSEP (including interaction with the predicted flight plan), leading to operational standards and performance requirements (including integrity for the flight management and predicted trajectory function). | |

#### 3.3.1.2 USER VFR Only GA

This section covers Low-End GA. In unmanaged airspace, the only requirement is for ADS-B OUT using low-cost system to be developed by 2011 (e.g. UAT).

#### 3.3.1.3 USER IFR Capable GA

This section covers High-End GA, VLJ Operators, IFR Helicopter Operators, factory demonstrations and flight trials, etc.
In addition to VFR requirements, the following enablers will be deployed:

- SBAS: install SATNAV system to utilise SBAS by 2011;
- ADS-B IN: install equipment to be selected through R&D after 2011;
- Enhance IFR Approach & Landing capabilities;
- SWIM connection, including Processing reception of aeronautical information and Meteo data.

#### 3.3.1.4 USER Military and State Aviation

Four categories of military airspace users are defined in accordance with the main categories of aircraft they use i.e. operators of large aircraft (military transport type aircraft), operators of fighter aircraft, operators of light aircraft (light civil and military aircraft, helicopters, paramilitary aircraft) and different types of UAS. All categories may fly GAT or OAT.
These 4 different categories of State aircraft will, for what their ATM-related avionics is concerned, be equipped with new CNS capabilities as defined for comparable categories of civil aircraft operators (commercial operators, business aviation, light aircraft operators) in order to ensure the required levels of civil-military ATM-interoperability.
Military Datalink Accommodation: use of available military Datalinks to support CPDLC, ADS-B/ASAS and other services require feasibility study to investigate a solution for interoperability (possibly with a ground interface).
As part of the Capability level 4 R&D, there is the need to determine solutions for military aircraft compliance with 4D Trajectory performance based navigation requirements including, where possible, the re-use of military enablers. Interoperability with military Datalinks, and use of FMS-alike Military Mission Systems to support trajectory management are areas to be investigated.
ACAS is not been considered required for other than military transport type aircraft.
Cat II/III capabilities are not considered required for State aircraft.

#### 3.3.1.5 USER UAV/UAS Operators

This section comprises civil and military UAV/UAS operators. The requirements are assumed to be the same as for equivalent GAT aircraft.
AGDLGMS shall recognise the nature of the exchange between ATC and UAS, to ensure the most efficient connectivity (ground-ground communication) between ATC and the UAS pilot.

### 3.3.2 Users (Aircraft Operators) – Flight Operations Centre

This roadmap covers all improvements required for the Airspace User Flight Operations Centre [9].

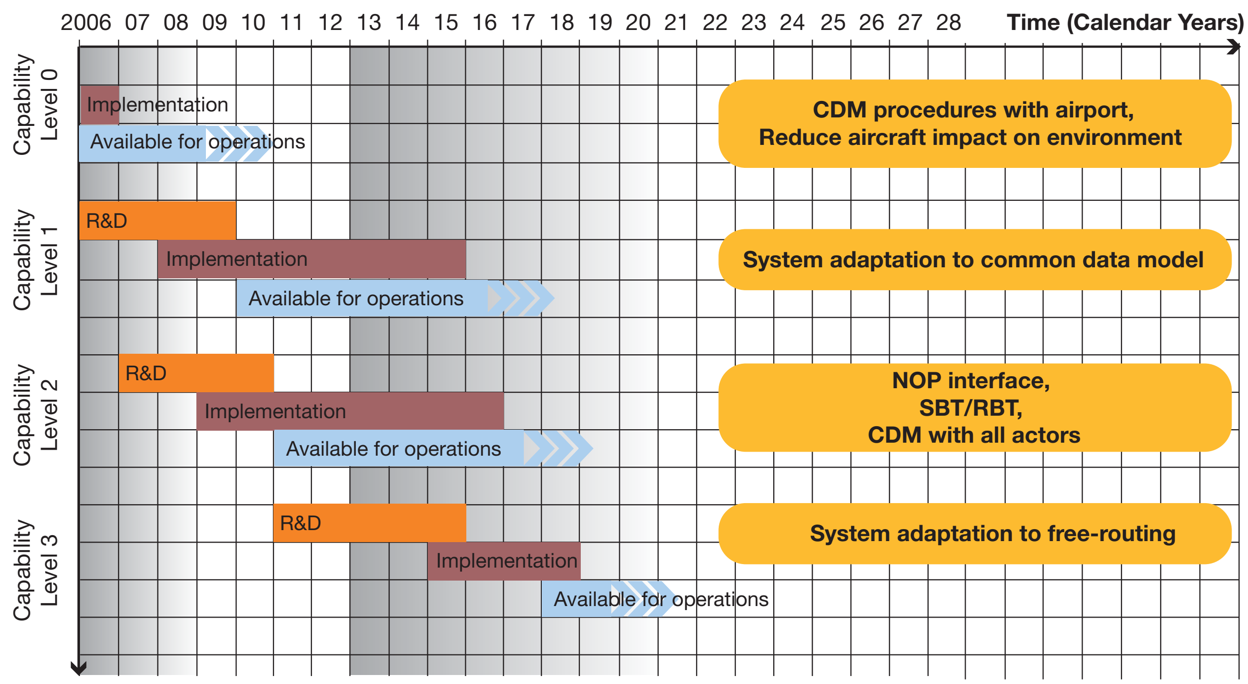



Figure 27: Users (Aircraft Operators) – FOC[10] roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **CDM procedures with airport:** Implement CDM information sharing for arrival, turn-around and for pre-departure sequencing | LoC#10 Airport Throughput, Safety and Environment |
| **Reduce aircraft impact on environment:** Implement Airline Operational Procedures for Minimization of Noise and Gaseous Emissions Impact on the Airport Surface | LoC#10 Airport Throughput, Safety and Environment |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **System adaptation to common data model:** Implement the data model to allow transfer of trajectory from FOC-ATM system into ATC world with SWIM. | LoC#5 Managing Business Trajectories in Real Time |
| **Capability Level 1 Required R&D** | |
| Develop and validate the introduction of new information model and trajectory format on the FOC systems. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **NOP interface:** Modification of FOC-ATM trajectory management system (or new systems) to allow quality of service requested by NOP for pre-flight trajectory. | LoC#3 Collaborative Planning using the NOP |
| **SBT/RBT:** Implement Airline Operational Procedures for creating and updating the Shared Business / Mission Trajectory. | LoC#5 Managing Business Trajectories in Real Time |

[9] Flight Operation Centre is a generic term covering Airline (or Wing) Operation Centre (AOC) ATM and Airspace User agent.
[10] for the case of Military Mission Trajectories similar capability/service might have to be available in Wing Operations Centres or other Military Centres

| | |
|---|---|
| **CDM with all actors:** Modification of FOC-ATM system to allow CDM processes with ATM world, in particular UDPP. | LoC#6 Collaborative Ground and Airborne Decision Making Tools |
| **Capability Level 2 Required R&D** | |
| Develop and validate principles and system evolutions for integration of FOC in ATM CDM processes (in particular UDPP, exploitation of data information exchanges with the DCB process). | |

| Capability Level 3 Deployment | Supports Line of Change |
|---|---|
| **System adaptation to free-routing:** Modification of FOC-ATM trajectory management system (or new systems) to allow quality of service requested by NOP for pre-flight trajectory with dynamic routing. | LoC#3 Collaborative Planning using the NOP<br>LoC#8 New Separation Modes |
| **Capability Level 3 Required R&D** | |
| Develop and validate FOC systems requirements to be able to propose free-route. | |

## 3.3.3 TMA and En-Route ANS Providers - ENR/APP ATC system

This enabler roadmap proposes enhancements related to data processing sub-systems and procedures used by ATCO for tactical control, planning and local/sub-regional traffic management in En-Route and Approach Centres.

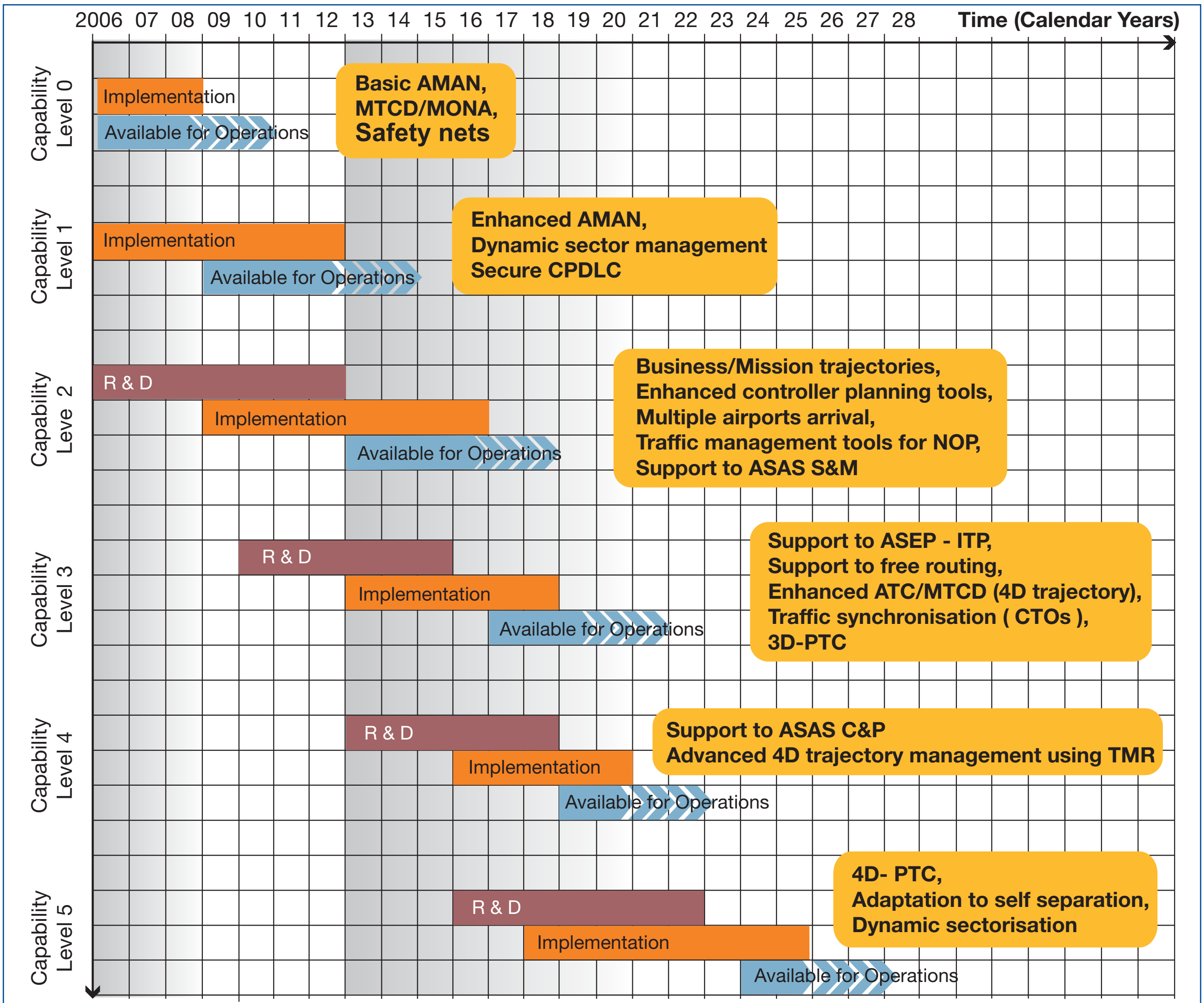



Figure 28: ANS Providers – ENR/APP ATC roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **Basic AMAN:** deploy AMAN in high density TMAs. | LoC#7 Queue Management Tools |
| **MTCD/MONA:** deploy FDP and controller workstation tools to identify potential conflicts and detect deviations from flight plan. | LoC#6 Collaborative Ground and Airborne Decision Making Tools |
| **Safety nets:** roll out ground based safety nets warning of area penetration, minimum safe altitude and approach path deviation. | LoC#9 Independent Cooperative Ground and Airborne Safety Nets |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **Enhanced AMAN:** deploy expanded-scope AMAN interfaced with en-route systems, and with DMAN and SMAN at local airports. | LoC#7 Queue Management Tools<br>LoC#10 Airport Throughput, Safety and Environment |
| **Dynamic Sector management:** Enhance FDP to support dynamic sectorisation and dynamic constraint management. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Secure CPDLC:** Deploy secure CPDLC Datalink services complementing voice communications (but not replacing them). | LoC#1 Information Management |
| **Capability Level 1 required R&D** | |
| Define and validate integration of AMAN/DMAN/SMAN local to one airport.<br>Define and validate ATC functions to support New Airspace Management principles (including civil/military coordination). | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Business/Mission Trajectories:** Deploy FDP and workstation tools using RBT and 3D Precision Trajectory (PT), based upon aircraft data, to provide constraints and clearances to aircraft. Deploy local/sub-regional traffic and capacity tools to use SBT/RBT. | LoC#6 Collaborative Ground and Airborne Decision Making Tools |
| **Enhanced controller planning tools:** Deploy tools to identify and automatically propose resolutions to complexity and hence increase throughput by deconfliction or synchronisation of flows, including conflict dilution through speed adjustment. Enhance tools to support free routing fro flight in cruise. | LoC#2 Moving from Airspace to Trajectory Based Operations LoC#3 Collaborative Planning using the NOP |
| **Multiple airport arrivals:** Deploy updated AMAN covering multiple airports in the TMA, and interface with FDP systems to take account of arrival sequence including user TTA and assignment of control time of arrival (CTA). | LoC#7 Queue Management Tools<br>LoC#10 Airport Throughput, Safety and Environment |
| **Traffic management tools for NOP:** Deploy enhanced traffic management tools to support use of shared NOP, taking into account controller task complexity. | LoC#6 Collaborative Ground and Airborne Decision Making Tools |
| **Support to ASAS (ASPA-S&M):** update ATC system to support ASPA- Sequencing &Merging. | LoC#8 New Separation Modes |
| **Capability Level 2 required R&D** | |
| Analyse the impact of a common trajectory data on ATC functions and information display: a/ how to merge the data coming from different sources with different QoS attributes, b/ how to display it according to the different sources considered and the impact on the use of this trajectory on the ATC tools. As a further step, integrate the ground processing of the TMR.<br>Develop tools and procedures for supporting controllers in handling free routing, with specific care of human aspects.<br>Define and validate ATC processes and tools to manage the various states of the Business Trajectory, transitions, segment clearances and RBT revisions.<br>Define and validate tools and processes to support complexity assessment and resolution at the level of ATC.<br>Develop Arrival Management to coordinate arrivals on several airports, and integrate with Departure and Surface Management. Develop procedures and tools to enable the definition of CTOs by ATC to smooth the traffic.<br>Define and validate downlink of aircraft parameters to improve ground Trajectory Prediction performance and enhance HMI tools for cooperative Ground-Ground and Air-Ground exchanges.<br>Define and validate ground tools to support ASAS Sequencing & Merging.<br>Develop new controller tools and methods including Conflict Management, Intent Management, MTCD&R, Multi Sector Planning, seamless coordination/transfer and conflict dilution by speed adjustment. | |

| Capability Level 3 Deployment | Supports Line of Change |
|---|---|
| **Support to ASEP–ITP:** modify sub-systems to recognize where delegation of separation is allowable, for In Trail Procedure | LoC#8 New Separation Modes |
| **Support to free-routing:** Enhance FDP systems to use 4D trajectory to support extended direct routing. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Traffic synchronisation (CTOs):** Update the ATC sub-systems to use Control Times Over-fly for sequencing at other intermediate merging points. | LoC#7 Queue Management Tools |
| **Enhanced ATC sub-systems/MTCD (4D trajectory):** Update ATC systems to enable use of RBT and PT published by airspace user through SWIM and provide constraints and clearances to aircraft systems; Deploy enhanced MTCD using 4D trajectory clearances and requests. | LoC#5 Managing Business Trajectories in Real Time<br>LoC#6 Collaborative Ground and Airborne Decision Making Tools<br>LoC#8 New Separation Modes |
| **3D PTC: deploy tools to support 3D PTC allocation** | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 3 required R&D** | |
| Define and validate ATC tools to support Air-Ground synchronisation related to the Business/Mission trajectory, including weather data, dynamic allocation of 3D route clearances and 4D-PTC, Air-Ground Safety Nets and Monitoring tools synchronisation.<br>Adapt ground Safety Nets to new separation modes and integrate down linked resolution advisories.<br>Develop tools and procedures for supporting controllers in handling generalised free routing, with specific care of human aspects. | |

| Capability Level 4 Deployment | Supports Line of Change |
|---|---|
| **Support to ASAS C&P:** update ATC system to support delegated aircraft Crossing & Passing separation. | LoC#8 New Separation Modes |
| **Advanced 4D trajectory management using TMR** | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 4 Required R&D** | |
| Define and validate ATC support functions required for ASAS C&P.<br>Finalize the validation of advanced 4D trajectory management using TMR (on top of the capability level 2 activities). | |

| Capability Level 5 Deployment | Supports Line of Change |
|---|---|
| **4D PTC:** Update the ATC sub-systems to fully exploit the airborne 4D trajectory. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Adaptation to self-separation:** Update the ATC sub-systems to support self-separation in mixed mode environment. | LoC#8 New Separation Modes |
| **Dynamic sectorisation without predetermined boundaries:** Update the ATC sub-systems to adapt ATC sectors' shape and volumes in real-time to respond to dynamic changes in traffic patterns and/or short term changes in users' intentions. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 5 required R&D** | |
| Define and validate ATC support functions required for self-separation.<br>Define and validate the ground and air capabilities and associated procedures to support the use of 4D-PTC in En-Route airspace. | |

### 3.3.3.1 Military as Air Navigation Service Provider

Military as ANS Providers include En-Route/Approach & Aerodrome ATC, Airspace Management entities, AIS support, SWIM and network interactions. Military ANS Provider follows the same roadmap as the civil ANS Provider, although not all enablers will be needed for the military operation in the same timeframe.

In the short to medium term military organisations will use the ICAO FPL format for OAT and GAT in a standardised way to support increased automated processing. Military organisations will migrate to the European AIS Database (EAD) adopting the AIXM data exchange model and follow further evolutions in AIM (e.g. digital NOTAM, new data exchange models). In the longer term military systems will support the migration from traditional flight planning to military

mission trajectory management and the future ICAO flight plan will be adopted for both OAT & GAT flights.
Existing military systems supporting ATM processes will be enhanced to support the exchange of data and information necessary for effective CDM processes. Military communication infrastructure and services will be enhanced in line with the new SWIM environment to support new ground-ground and air-ground applications. Connectivity with the SWIM network and a military Datalink capability for ATM purposes will be defined.
Capabilities of military Airspace Management (ASM) systems will be enhanced to support collaborative airspace planning hence flexible use of airspace. Flexible Military Training Areas will be used as part of the integrated airspace planning throughout Europe. Real-time airspace status information will become available. Military will contribute to the pan-European airspace data repository.
The key system in support of Air Traffic Flow and Capacity Management (ATFCM) is the Network Information Management System (NIMS) that is in charge of ensuring the support at the regional level of the collaborative processes with local/sub-regional (Airport, ACC, and FAB) actors and all Airspace Users including military authorities. Supports ATFCM and ASM decision processes in managing civil and military demand (traffic and airspace usage) involving authentications and authorizations to protect confidential and sensitive data.
Although Air Defence entities are not considered military ANS Providers, they need to be considered for some of the enabler packages. Introducing system capabilities related to airspace security and connecting to the SWIM-environment will be of paramount importance.

### 3.3.4 Airport ANS Provider - Aerodrome ATC system

This enabler roadmap covers all improvements required for the ATC and navigation part of Airport service provision.

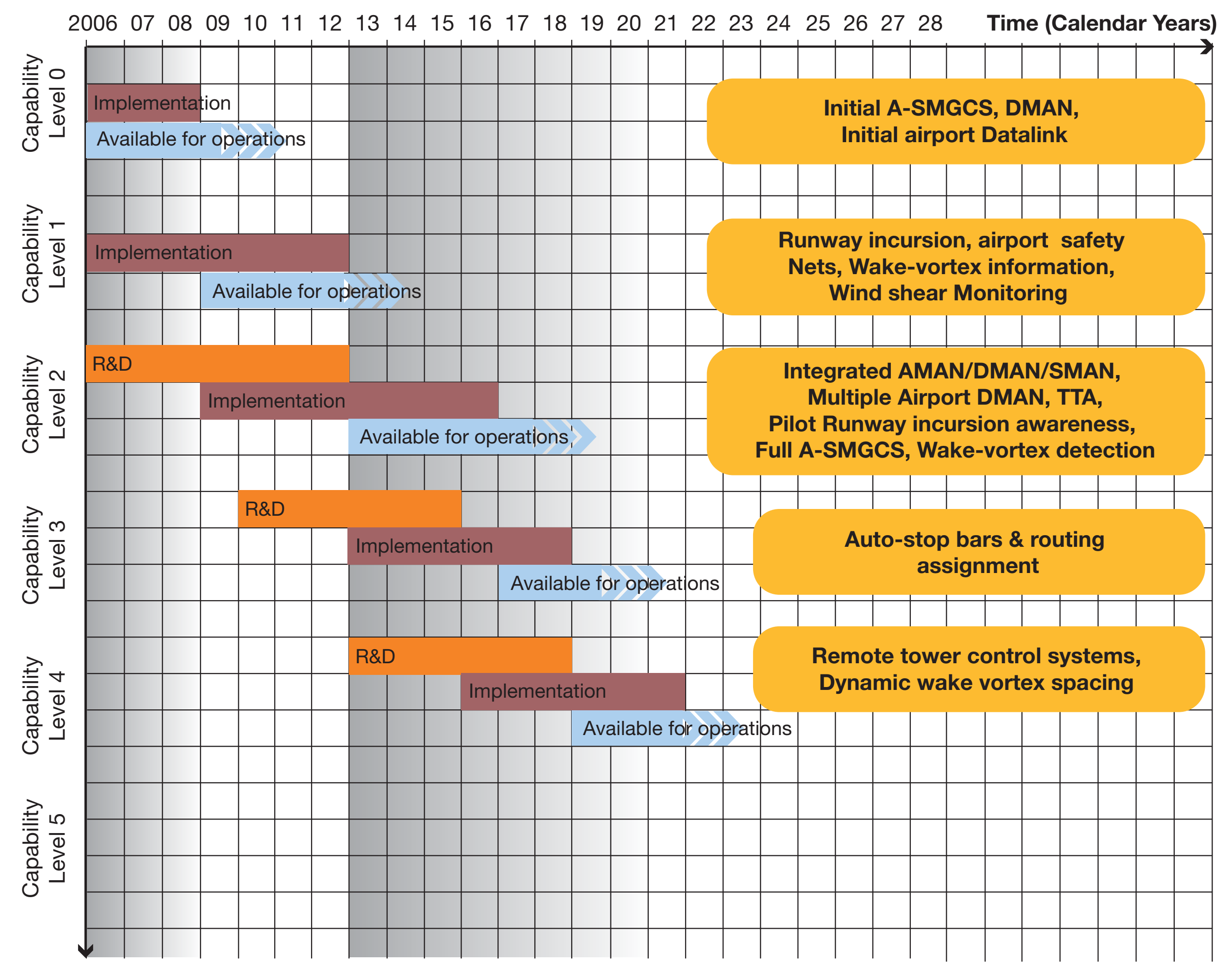



Figure 29: ANS Provider – Aerodrome ATC roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **Initial A-SMGCS:** Deploy Advanced Surface Movement Guidance and Control System for the surveillance of all mobiles on the manoeuvring area. | LoC#10 Airport Throughput, Safety and Environment |
| **DMAN:** Deploy Departure Management system. | LoC#7 Queue Management Tools |
| **Initial Airport Datalink:** Deploy Departure clearance (DCL) and Digital Aeronautical Terminal Information Service (ATIS) through Datalink (ACARS). | LoC#10 Airport Throughput, Safety and Environment |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **Runway Incursion:** Deploy a system that detects runway incursion providing controllers with appropriate alerts, thus resulting in an increased safety. | LoC#10 Airport Throughput, Safety and Environment |
| **Airport Safety Nets:** Deploy Automated assistance to Controllers in resolving detected conflicts concerning mobiles on the movement area. | LoC#10 Airport Throughput, Safety and Environment |
| **Wake-vortex Information:** Deploy Runway Usage Management sub-system enhanced for processing static wake-vortex information. | LoC#10 Airport Throughput, Safety and Environment |
| **Wind shear Monitoring:** Deploy Surface movement control workstation equipped with a wind shear monitoring tool. | LoC#10 Airport Throughput, Safety and Environment |
| **Secure CPDLC:** Deploy secure CPDLC Datalink services complementing voice communi-cations (but not replacing them). | LoC#1 Information Management |
| **Capability Level 1 required R&D** | |
| Completed. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Integrated AMAN/DMAN/SMAN:** Deploy modification of surface movement data processing system for integration with Departure Manager, Arrival Manager (via Runway Usage Manager) and En-Route FDPS in order to improve the aerodrome throughput, especially at airports with runways used for both arriving and departing flights. | LoC#7 Queue Management Tools |
| **Multiple Airport Departure Manager (DMAN):** Deploy DMAN enhanced to handle departure from multiple airports. | LoC#7 Queue Management Tools |
| **Target Time of Arrival (TTA):** Deploy enhanced arrival/departure sequence management system with external aerodrome and CDM, taking into account the user Target Time of Arrival. | LoC#7 Queue Management Tools |
| **Pilot Runway incursion awareness:** Implement automatic uplink of the alert to avoid runway incursion. | LoC#10 Airport Throughput, Safety and Environment |
| **Full ASMGCS:** Deploy upgraded Advanced Surface Movement Guidance and Control System (ASMGCS) to support ATCOs surface operations (routing, planning, automatic guidance). | LoC#10 Airport Throughput, Safety and Environment |
| **Wake-vortex detection:** Integrate wake-vortex information in runway management system thus allowing time-based separation. | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 2 required R&D** | |
| Develop rules and validate system updates to integrate arrival and departure management constraints.<br>Develop and validate processes supporting CDM in order to ensure efficiency of the processes and benefits for the network.<br>Develop and validate use of glide path guidance and runway threshold/touchdown markings for safe “Land long” Hi/Lo glide path operations.<br>Develop and validate means to coordinate pre-selected runway exit between ground controller and flight crew.<br>Develop and validate the data exchange and associated procedures for issuing TTAs from destination AMAN in response to a departure request from the DMAN at origin. | |

| Capability Level 3 Deployment | Supports Line of Change |
|---|---|
| **Auto-stop bars and routing assignment:** Implement procedures for standardised usage of auto-stop bars and routing assignment. | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 3 required R&D** | |
| Develop and validate procedures for standardised usage of auto-stop bars and routing assignment. | |

| Capability Level 4 Deployment | Supports Line of Change |
|---|---|
| **Remote Tower Control System:** Deploy ATC Procedures (Airport) for providing services to a remote location potentially including but not limited to traffic information, separation provision, Meteo alerts, and alerting services[11]. | LoC#10 Airport Throughput, Safety and Environment |
| **Dynamic Wake-vortex spacing:** Deploy ATC Procedures for authorising dynamic wake vortex spacing. | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 4 required R&D** | |
| Develop and validate procedures and means to support remote tower control operations. | |
| Develop and validate procedures and means to support dynamic wake-vortex spacing. | |

### 3.3.5 Airport Operator – Airport Airside Operations Systems

This enabler roadmap proposes enhancements related to Airport Airside Operations systems.

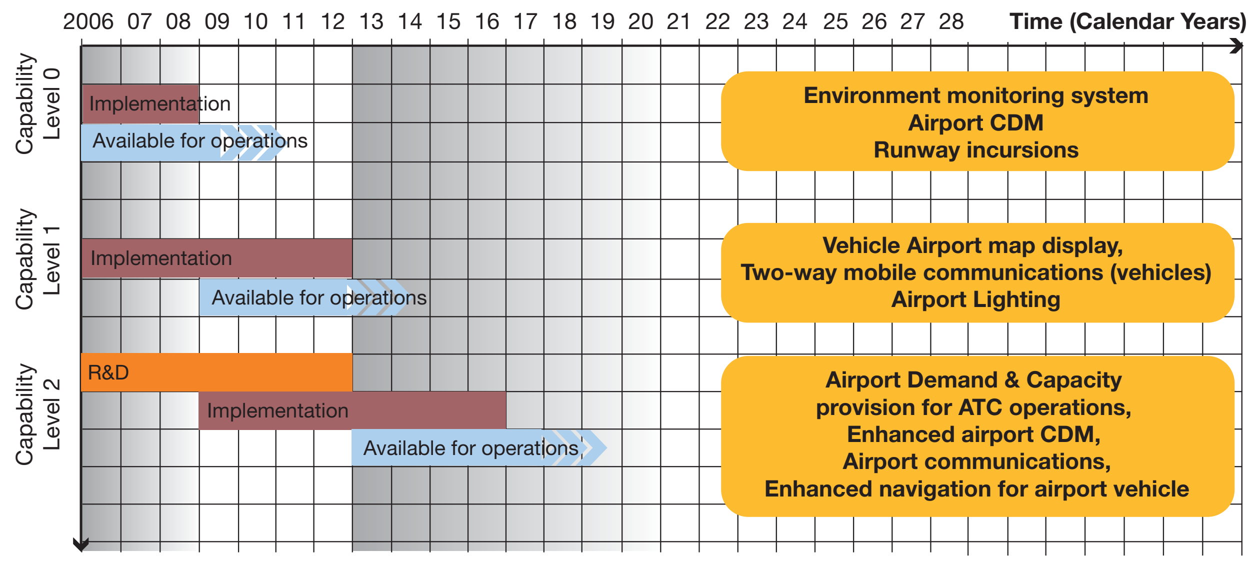



Figure 30: Airport Operator – Airport Airside Operations roadmap

11 Depending on early results from the R&D and specific regional needs, early implementation might be achievable.

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **Environment monitoring system:** deploy system to monitor noise, air quality, and emissions. | LoC#10 Airport Throughput, Safety and Environment |
| **Airport CDM:** implement airport CDM procedures at Airport, including information sharing, turnaround process, (milestone approach), variable taxi time calculation elements, collaborative pre departure sequence and collaborative decision in adverse conditions. | |
| **Runway Incursions:** implement procedures and apply recommendations contained in the European Safety Action Plan for the prevention of runway incursions. | |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **Vehicle Airport static map display:** Implement in all vehicles expected to enter the airport manoeuvring area a static map of the airport showing taxiways, runways, obstacles and the mobile's own position. As an additional step enhance to include display of dynamic traffic context (e.g. status of runways, taxiways). | LoC#10 Airport Throughput, Safety and Environment |
| **Two-way mobile communications (vehicles):** Implement a two-way communications equipment in all vehicles expected to enter the airport manoeuvring area. | LoC#10 Airport Throughput, Safety and Environment |
| **Airport Lighting:** Upgrade and or replace airport lighting with LED technology. | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 1 required R&D** | |
| Develop and validate LED lighting applied to areas other than taxiways to address issues as hue, brightness etc as well as further development effort by the manufacturers to create sufficient brilliance. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Airport Demand & Capacity provision for ATC operations:** Update airport systems to interface with Surface movement control workstation SMAN integrated with enhanced DMAN and AMAN tools providing departure constraints that take into account arrival constraints and planned taxi times. | LoC#7 Queue Management Tools |
| **Enhanced Airport CDM:** Update airport systems to take into account CDM processes enhanced to exploit all information available by SWIM. | LoC#1 Information Management |
| **Airport Communications:** Introduce new airport Wimax communication system. | LoC#10 Airport Throughput, Safety and Environment |
| **Enhanced navigation for airport vehicles:** Airport vehicle equipped with airport map display (including traffic and dynamic operations). | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 2 required R&D** | |
| Develop, test and validate processes and perform necessary technical integration to enable enhanced Airport CDM.<br>Develop and validate system enhancement to support the management of traffic complexity to improve airport surface operations. | |

### 3.3.6 Regional Airspace and Network Manager

#### 3.3.6.1 Regional Airspace Manager - AAMS

Advanced Airspace Management System (AAMS) supports the airspace organisation and management at regional level. Airspace management systems and procedures will be enhanced to support collaborative airspace planning, user-preferred routing and advanced flexible use of airspace

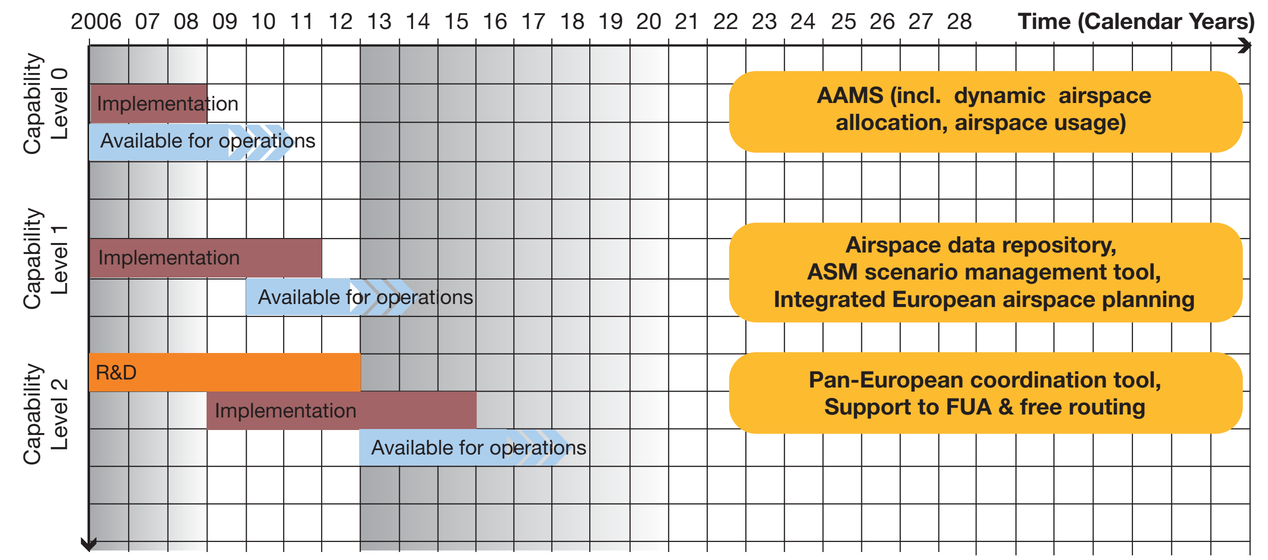



Figure 31: Regional Airspace Manager – AAMS roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **AAMS:** implement Advanced Airspace Management System (AAMS) accommodating real-time functions and dialogues for dynamic airspace allocation and enabling to generate/distribute planned airspace usage information. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#3 Collaborative Planning using the NOP |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **Airspace data repository:** implement a common and consistent source of airspace information for Regional Information Management, National/Local system, and European aeronautical database. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **ASM Scenario Management:** implement Scenario management sub-system equipped with tools to support pre-tactical CDM. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Integrated European airspace planning:** update AAMS to support the integrated European airspace planning process. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 1 required R&D** | |
| Define and validate CDM principles and processes to support scenario management.<br>Develop and validate integration of meteorological data in support of scenario management. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Pan-European coordination tool:** equip Advanced Airspace Management System with a pan-European airspace coordination tool. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Support to FUA & Free Routing:** update AAMS to support Flexible Use of Airspace (FUA) and free routing, European-wide use of Military Training Area, common information model. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 2 required R&D** | |
| Evaluate how existing airspace management tools need to be adapted to support management of new airspace categories, free routing areas, FUA and the determination of the optimal airspace design according to traffic demand. | |


Issued by the SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL

### 3.3.6.2 Regional Network Manager - NIMS

This enabler roadmap proposes enhancements related to Network Information Management System

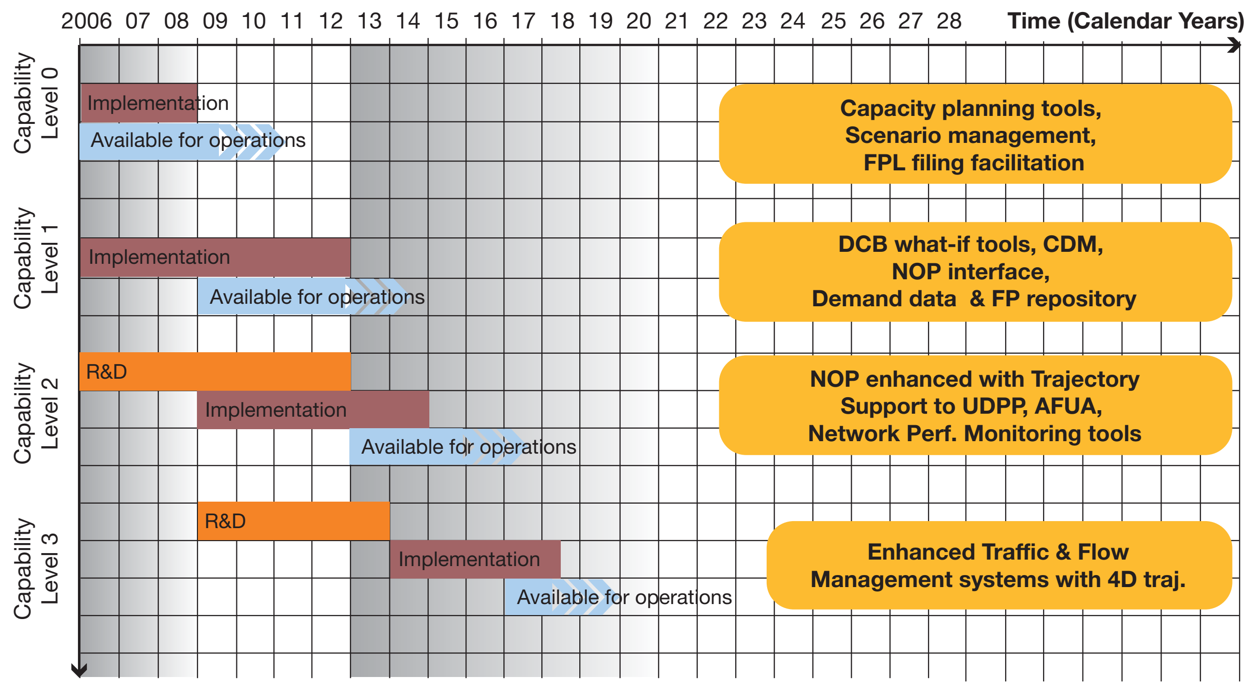



Figure 32: Regional Network Management - NIMS roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **Capacity planning tools:** implement capacity planning tools to assist ATS Providers in the provision of operational capacity plans. | LoC#4 Managing the ATM Network |
| **Scenario management:** implement assistance tools for use in the strategic or pre-tactical timeframes, allowing ATFCM partners to identify operational ATFCM measures. | LoC#3 Collaborative Planning using the NOP<br>LoC#4 Managing the ATM Network |
| **FPL filing facilitation:** update Flight Planning management sub-system to disseminate flight plan updates, facilitate flight plan filing and revisions, enable access to archives, offer flight planning syntax assistance tools. | |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **DCB what-if tools:** Implement tools for simulating, evaluating the balance between demand and capacity taking into account airline and airport schedule data. | LoC#3 Collaborative Planning using the NOP<br>LoC#4 Managing the ATM Network |
| **CDM:** implement tools to assist ATS provider in identifying available capacity through CDM processes, selecting optimised ATFCM solutions (e.g. Re-routing, FL Management, and Advancing Traffic, optimisation of use of airport holding patterns). | LoC#3 Collaborative Planning using the NOP |
| **NOP interface:** Implement external access to the Network Operations Plan through a portal. | LoC#3 Collaborative Planning using the NOP |
| **Demand Data and FP repository:** implement Demand Data Repository to collect flight intentions. Implement Flight Plan Repository for external access as a reference database for flight plans as well as the associated history of the flight plan. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 1 required R&D** | |
| Develop and validate NOP and CDM rules, policies and processes. | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **NOP enhanced with Trajectory:** Implement NOP update mechanisms making use of Trajectory information. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#3 Collaborative Planning using the NOP |
| **Support to UDPP, A-FUA:** support Airspace Users in their User Demand Prioritisation Process (UDPP). Support the evaluation of reactive ad-hoc scenarios, in close cooperation with AAMS/Military activity planning. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#5 Managing Business Trajectories in Real Time |
| **Enhanced Network Performance Monitoring tools:** support the continuous performance assessment of the network by providing all actors with measurement data to be used for continuous improvement. | LoC#4 Managing the ATM Network |
| **Capability Level 2 required R&D** | |
| Develop and validate roles of AOC and Network arbitrator in the UDPP process.<br>Develop and validate NOP update mechanisms making use of Trajectory information. Validate capacity of network management to implement reactive scenarios (dynamic military areas, real-time events). | |

| Capability Level 3 Deployment | Supports Line of Change |
|---|---|
| **Enhanced Traffic & Flow Management systems to support 4D trajectory:** Update Traffic and Flow Management sub-systems to support dynamic flow management in co-ordination with local, regional, and European levels. | LoC#4 Managing the ATM Network |
| **Capability Level 3 required R&D** | |
| Develop and validate systems based on use of shared 4D trajectory to manage traffic flows and constraints (CTA, CTOs). | |

### 3.3.7 CNS Infrastructure Operator - CNS Systems and Infrastructure

This enabler roadmap proposes enhancements related to ground CNS systems and infrastructure

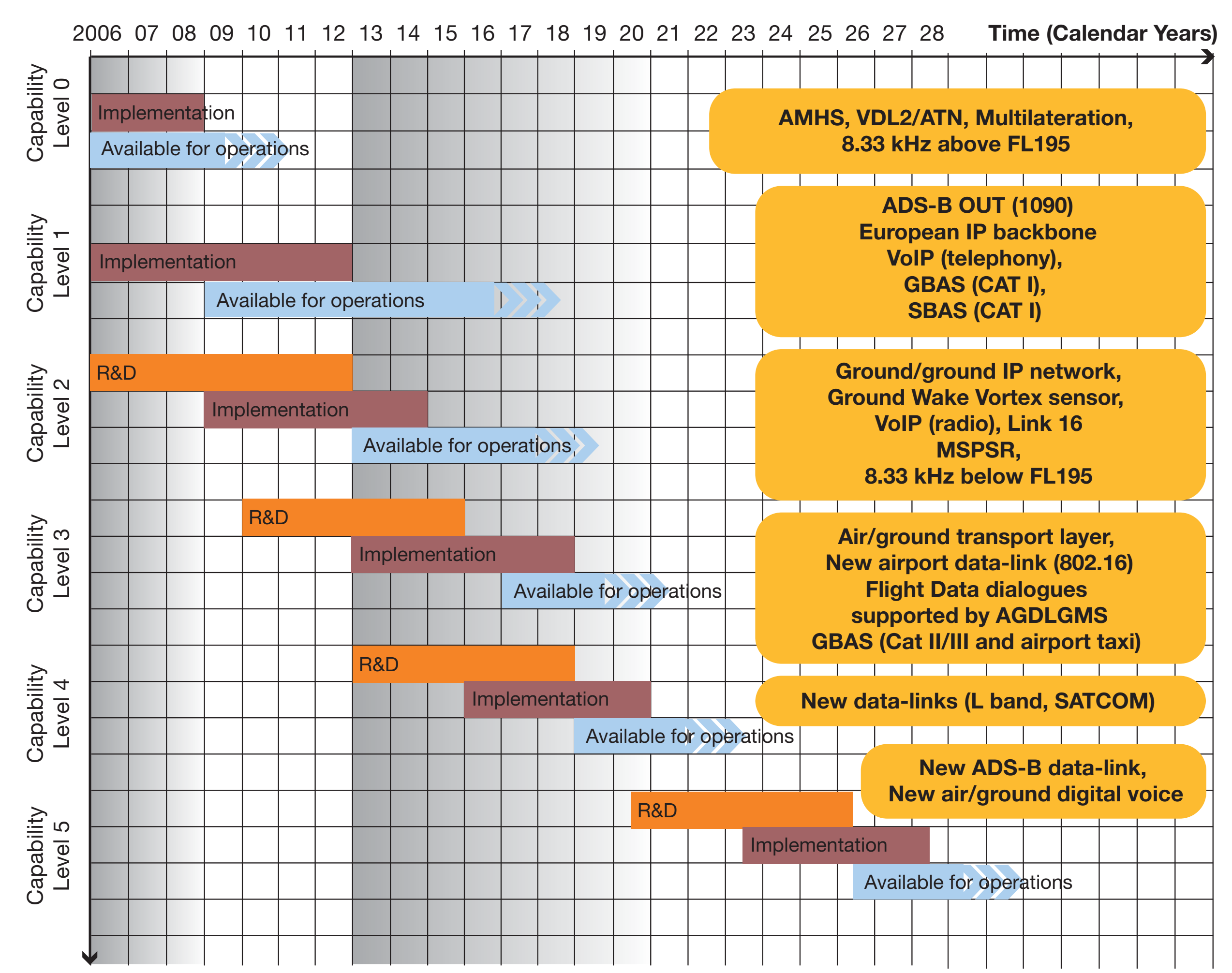



Figure 33: CNS Provider - CNS Systems and Infrastructure roadmap

| Capability Level 0 Deployment | Supports Line of Change |
|---|---|
| **AMHS:** Deploy Ground-ground data communication messaging services to interconnect stakeholder's systems. | LoC#1 Information Management<br>LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#3 Collaborative Planning using the NOP |
| **VDL2/ATN:** Deploy VDL2 ground stations and ATN routers interfaced with ATC systems. | LoC#1 Information Management<br>LoC#5 Managing Business Trajectories in Real Time<br>LoC#8 New Separation Modes |

| | |
|---|---|
| **Multilateration:** Deploy Wide Area Multilateration(WAM) for En-route and TMA airspace and deploy airport Multilateration (MLAT) as options to support surveillance function. | LoC#6 Collaborative Ground and Airborne Decision Making Tools<br>LoC#9 Independent Cooperative Ground and Airborne Safety Nets<br>LoC#10 Airport Throughput, Safety and Environment |
| **8.33 above FL195:** Deploy 8.33KHz in all airspace above FL195. | LoC#5 Managing Business Trajectories in Real Time |

| Capability Level 1 Deployment | Supports Line of Change |
|---|---|
| **ADS-OUT (1090):** Install Mode S 1090 ground receiving stations to support ADS-B out based surveillance. | LoC#6 Collaborative Ground and Airborne Decision Making Tools<br>LoC#8 New Separation Modes<br>LoC#10 Airport Throughput, Safety and Environment |
| **European IP backbone:** Interconnect state data networks through a European IP based backbone. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#3 Collaborative Planning using the NOP<br>LoC#5 Managing Business Trajectories in Real Time<br>LoC#6 Collaborative Ground and Airborne Decision Making Tools<br>LoC#7 Queue Management Tools |
| **VoIP:** Deploy Voice over IP for ATC Ground-ground voice telephony communication. | |
| **GBAS (CAT I):** Implement GBAS ground stations to provide Cat I operations. | LoC#10 Airport Throughput, Safety and Environment |
| **SBAS:** Deploy EGNOS system to support SBAS APV Cat I (to LPV). | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 1 required R&D** | |
| Develop and validate GBAS Cat I capability, as a stepping stone towards Cat III.<br>Assess aeronautical spectrum requirements for air, ground and space segments | |

| Capability Level 2 Deployment | Supports Line of Change |
|---|---|
| **Ground/ground IP network:** Complete the overall IP based and integrated European network by interconnecting all state data networks. | LoC#2 Moving from Airspace to Trajectory Based Operations<br>LoC#3 Collaborative Planning using the NOP<br>LoC#5 Managing Business Trajectories in Real Time<br>LoC#6 Collaborative Ground and Airborne Decision Making Tools<br>LoC#7 Queue Management Tools |
| **Ground Wake Vortex sensors:** implement next generation ground weather and ground wake vortex sensors. | |
| **VoIP (radio):** Deploy Voice over IP between ATC and radio station on the ground-ground segment. | |
| **MSPSR:** Implement new Primary Radar with multi-static technology to replace the existing ones. | |

| | |
|---|---|
| **Link 16:** Implement ground gateways to accommodate Military link16 equipped aircraft within civil ATM system to provide initial D/L services. | LoC#1 Information Management<br>LoC#2 Moving from Airspace to Trajectory Based Operations |
| **New airport D/L (802.16):** Install new airport wireless Datalink in protected aeronautical spectrum (C band) to support ATM communication services[12]. | LoC#5 Managing Business Trajectories in Real Time<br>LoC#10 Airport Throughput, Safety and Environment |
| **Airport Lighting:** Upgrade and or replace airport lighting with LED technology. | |
| **8.33 below FL195:** Deployment of 8.33 KHz in airspace below FL195 if deployment case is made and accepted. | |
| **Capability Level 2 required R&D** | |
| Identify the detailed operational requirements for Datalink messages to support European operation (e.g. Meteo and trajectory).<br>Develop a performance validation demonstrator to identify the capability and the potential risks of MSPSR technology.<br>Develop and validate solutions that enable existing military Datalink solutions to interoperate with civil Datalinks, while safeguarding military classified data.<br>Identify the detailed operational requirements for new airport Datalink. Develop the air and ground component technical specifications and initial standard for the new airport surface Datalink; validate the detailed and overall performance capabilities and electromagnetic compatibility with other aircraft and airport systems. Propose and consolidate spectrum allocation at global level (ITU).<br>Develop and validate ground wake vortex detection radar.<br>Develop and validate next generation weather radar.<br>Develop and validate LED technology as an acceptable replacement, while meeting improved signalling and environment performance. | |

| Capability Level 3 Deployment | Supports Line of Change |
|---|---|
| **Air/ground transport layer:** Deploy Common transport protocol for air/ground data communication (ATN Vs IP protocol evolutions) | |
| **Flight Data dialogues supported by AGDLGMS:** Deploy through AGDLGMS dialogues related to flight data between Aircraft and the responsible Controller. | |
| **GBAS (Cat II/III and airport taxi):** Deploy GBAS ground stations to provide CatII/III capability and low visibility surface taxiway exploiting dual GNSS constellation (GPS + Galileo). | LoC#10 Airport Throughput, Safety and Environment |
| **Capability Level 3 required R&D** | |
| Investigate Quality of service management offered by candidate protocols (ATN/IP) and finalize technical specification of the evolution of the selected protocol.<br>Define ATM scenario scoping the needs for positioning with GNSS as principal means - providing a decision on the constellation combinations: by 2009 for flight operations and 2012 for high precision surface positioning.<br>Develop capability GBAS CAT III exploiting Galileo and GPS constellations. Develop and validate the air and ground component technical specifications and initial standard. Investigate feasibility to provide GBAS CAT II/III (L1) in specific operating environments.<br>Develop and validate AGDLGMS principles through prototypes. | |

| Capability Level 4 Deployment | Supports Line of Change |
|---|---|
| **New Datalinks (L band and SATCOM):** implement a new terrestrial L-Band Datalink and a new SATCOM air-ground Datalink to complement VDL2, in support of more demanding services. | LoC#2 Moving from Airspace to Trajectory Based Operations |
| **Capability Level 4 required R&D** | |
| Develop and validate space/air/ground architecture for the new L-band link and the new satellite link. Assess and support consolidation of European-wide spectrum requirements.<br>Develop and validate the selection of the technology for the future terrestrial L band Datalink by developing initial prototypes to support feasibility assessment. By 2010, in coordination with other regions (e.g. USA), make final technology selection to allow the development of the technical specifications to be included in ICAO SARPS and Manual.<br>Develop and validate prototype for the development of new Satellite communication system (including specifications to be included in ICAO SARPS and Manual). | |

[12] Initial operation may start before all standardisation is completed.

| Capability Level 5 Deployment | Supports Line of Change |
|---|---|
| **New Datalinks (ADS-B):** implement a new ADS-B Datalink to support more demanding services. | LoC#8 New Separation Modes |
| **New air/ground digital voice:** implement new digital air-ground voice communication corresponding to the new needs for voice communication. | |
| **Capability Level 5 required R&D** | |
| Develop and validate the selection of the technology for the future ADS-B L band Datalink by developing initial prototypes to support feasibility assessment. By 2010, in coordination with other regions (e.g. USA), make final technology selection to allow the development of the technical specifications to be included in ICAO SARPS and Manual.<br>Assess potential voice saturation issue to determine if further activities are needed on air ground Digital voice. Develop and validate requirement as necessary. | |

### 3.3.8 Regional SWIM Manager – SWIM supervision

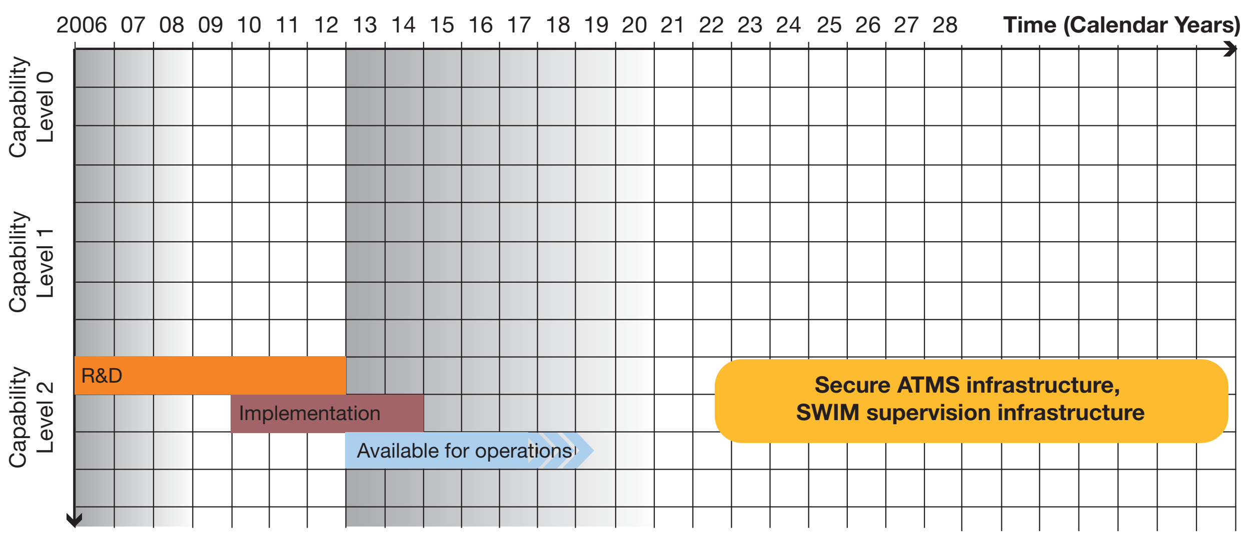



Figure 34: Regional SWIM Supervisor - SWIM supervision

| Capability Level 2 Deployment |
|---|
| **SWIM supervision mechanisms:** Implement Regional supervision mechanism and recording. |
| **Capability Level 2 Required R&D** |
| Develop and validate SWIM supervision mechanism using commercially available systems where available. |

### 3.3.9 Aeronautical Information Providers

Aeronautical Information Providers produce and publish Aeronautical information to SWIM. Meteorological information is considered as one of the key Aeronautical Information types.

#### 3.3.9.1 Aeronautical Information Providers - General

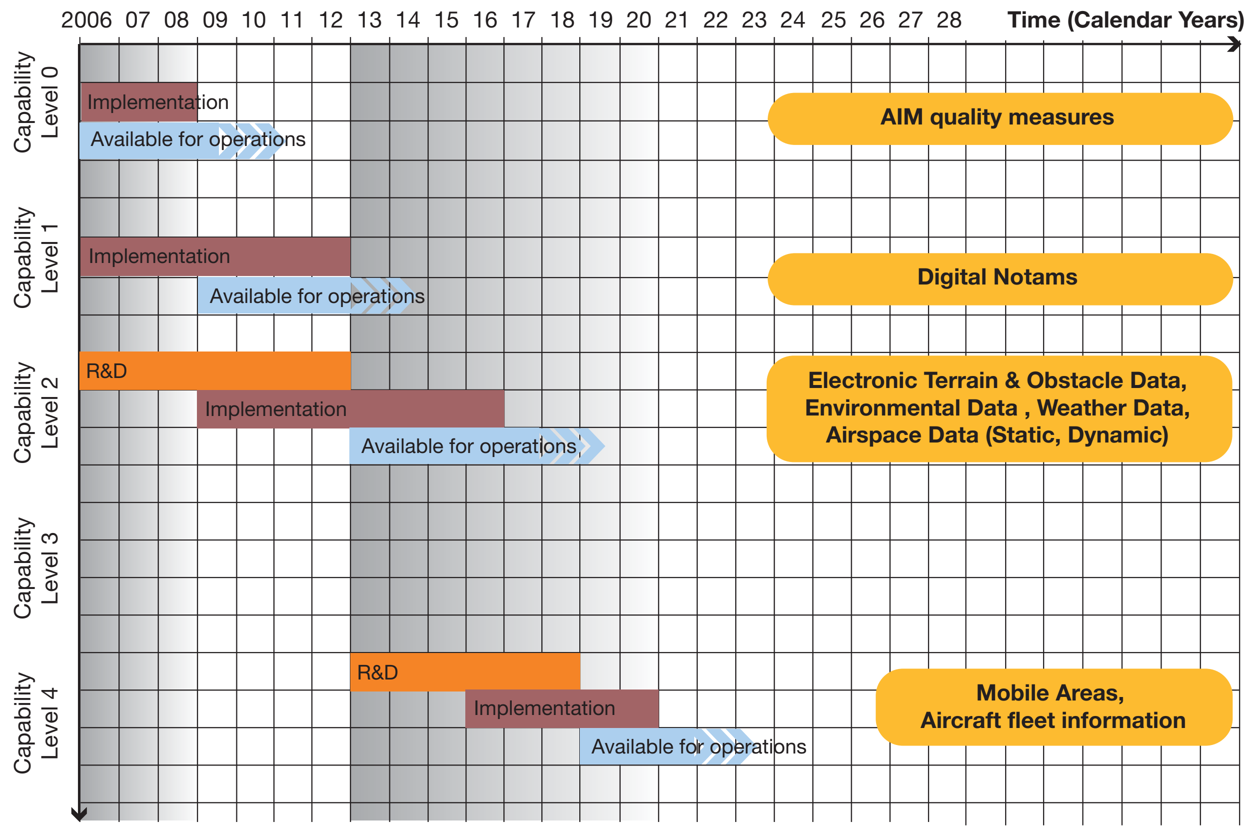



Figure 35: Aeronautical Information Management – AIMS roadmap

| Capability Level 0 Deployment |
|---|
| **Quality measures:** Implement common quality measures for aeronautical data (e.g. Controlled and Harmonized Aeronautical Information Network -CHAIN). |

| Capability Level 1 Deployment |
|---|
| **Digital Notams:** Implement XNOTAM for further automatic processing by stakeholders systems. |

| Capability Level 1 Required R&D |
|---|
| None required |

| Capability Level 2 Deployment |
|---|
| **Electronic Terrain and Obstacle Data:** Implement electronic Terrain and Obstacle Data processing, taking into account aircraft databases. |
| **Airspace Data (static, dynamic):** Implement electronic airspace data processing |
| **Weather Data:** Implement electronic weather data processing |
| **Environmental Data:** Accommodate major environmental data requirements. |
| **Capability Level 2 Required R&D** |
| Develop and validate common air/ground obstacle and terrain data model and exchange protocols (in conjunction with the ATM reference model). |

| Capability Level 4 Deployment |
|---|
| **Mobile Areas:** Update aeronautical information system to enable handling Dynamic Mobile Areas. |
| **Aircraft Fleet Information:** Implement common static aircraft fleet reference data and support access for all stakeholders. |
| **Capability Level 4 Required R&D** |
| Develop and validate common air/ground dynamic mobile data model and exchange protocols (in conjunction with the ATM Reference model). |

### 3.3.9.2 Aeronautical Information Providers – Meteorological system

Detailed knowledge about the past, current and future state of the atmosphere, provided as Aeronautical Meteorological Information (MET), is a key enabler of the SESAR ATM Concept of Operations.

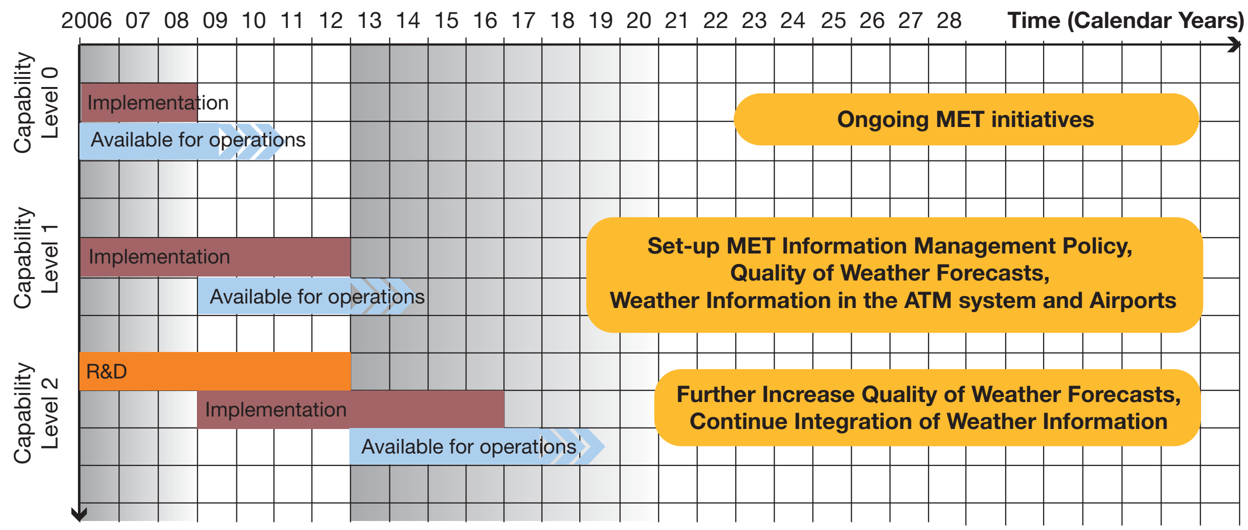



Figure 36: Aeronautical Meteorological Information (MET) Provider - Meteo roadmap

| Capability Level 0 Deployment |
|---|
| **Ongoing MET initiatives:** Harmonization of already existing integrated briefing systems. |

| Capability Level 1 Deployment |
|---|
| **Set-up MET Information Management Policy:** Harmonise meteorological information (regulatory aspects) across all flight domains, including oceanic and international flights and continuity from pre-flight to post-flight operations in support of global application. |
| **Increase Quality of Weather Forecasts:**<br>Provide probabilistic weather forecasts in support of making greater use of congested/constrained En-Route airspace.<br>Improve the accuracy, timeliness and forecast range of convective weather information (including lightning), turbulence and icing.<br>Improve accuracy reliability and lead time of visibility/ceiling forecasts and include a measure of uncertainty.<br>Provide high accuracy, high resolution short range wind forecasts. Harmonize use of specialized forecasts for de-icing and snow clearance during winter conditions.<br>Provide forecast of hazardous weather phenomena including low level windshear and temperature inversions (terminal area).<br>Provide weather observations and weather forecasts of wind aloft for approach and departure flight operations and runway selection procedures.<br>Provide observed and forecasted meteorological parameters related to the braking action of the movement area of the airport to reduce capacity loss. |
| **Integrate Weather Information in the ATM system:**<br>Integrate regulated existing and future Met information into the WXXM (weather information exchange model), in conjunction with the ATM Reference model.<br>Include climatology factors into long term planning through conditional climatology methods.<br>Include seasonal forecasts to define optimum routes to be used for schedule and airport/airspace strategic slot planning<br>Use observations and forecasts of volcanic ash and other severe contaminant releases for tracking and display purposes in support of air navigation safety.<br>Integrate meteorological information into Decision Making Support tools in support of network efficiency.<br>Integrate existing convective weather information (including lightning), turbulence and icing in a harmonized way into ATM decision support tools.<br>Adapt existing short term forecasts of visibility/ceiling to specific user requirements and integrate them in CDM processes for Low Visibility Conditions.<br>**Deploy Weather Information Systems at Airports**<br>Deploy weather observation/forecasts and dissemination systems that enable airport utilization with increased predictability and reliability of operations. |
| **Capability Level 1 R&D** |
| Develop and Validate accuracy and timeliness of MET data (e.g. forecast and observation) to support dynamic modification of airspace sectors and dynamic terminal configuration.<br>Develop and Validate improvements of forecasts of hazardous weather phenomena required for ATM operations (e.g. low level windshear).<br>Develop and Validate improvements of Met data to prevent formation of persistent contrails.<br>Develop and Validate improvements of Numerical Weather Prediction Systems (NWP) capabilities by using information acquired from on board sensors (e.g. use of additional parameters like humidity). |

| Capability Level 2 Deployment |
|---|
| **Further Increase Quality of Weather Forecasts**<br>Increase accuracy and timeliness of meteorological information in support of dynamic modification of airspace sectors.<br>Improve weather observations and very short-range terminal weather forecasts in support of dynamic terminal area configuration to mitigate the effects on capacity and safety.<br>Improve forecast of hazardous weather phenomena including low level windshear and temperature inversions (terminal area).<br>Provide meteorological information to prevent the formation of persistent contrails in serving the environmental impact of air transport. |
| **Continue Integration of Weather Information:**<br>Further integrate existing onboard weather sensors (e.g. WMO AMDAR programme) to improve nowcast and forecast capabilities to meet service level 2 & 3 requirements.<br>Integrate weather information into decision oriented tools in support of dynamic terminal area configuration to mitigate the effects on capacity and safety. |
| **Capability Level 2 Required R&D** |
| Develop and Validate improvement of<br>- the quality of weather forecast;<br>- the integration of weather information<br>based on the first experiences in use of additional and more accurate weather information. |

# 4 Benefits and Financing

The main challenge for the Master Plan is to define an evolutionary path, in which performance closely matches the targets, optimises the benefits and secures the financial viability of its deployment. While the focus of the benefits planning for the 2020 ATM Target Concept is mainly on the cost effectiveness and capacity, including the quality of services, benefits are anticipated in all KPAs. The chapter addresses the evolution to ATM Service Level 3 and is divided in two distinctive parts. The first part addresses the benefits, while the second focuses on the investment and financial aspects.
This chapter builds on the work and assumptions used in D4 [Ref. 5] and in particular its Annex 5.

Caveat:
- All information and data in this chapter are the results from an initial assessment on expected performance, benefits and costs of the proposed deployment of the identified operational improvements;
- For the sake of clarity and simplicity of presentation, performance, benefit and costs values are not presented with ranges but as single values; nevertheless it should be clearly understood that these values represent cases subject of various uncertainties.

Further validation during all life cycle phases of the Master Plan implementation is essential.

## 4.1 Societal Benefits

The implementation of the ATM Target Concept directly contributes to mobility, regional development and tourism. The consideration of societal benefits in this chapter specifically addresses GDP, and the safety and environmental sustainability of the air transport infrastructure.

Without the Master Plan implementation, air traffic growth will be unduly constrained and with it the present benefits from air transport to the European society will lessen. Figure 37 shows the sum of the direct, indirect and induced aviation contributions to the European GDP to be of some €222Bn in 2004 (EUROCONTROL, The Economic

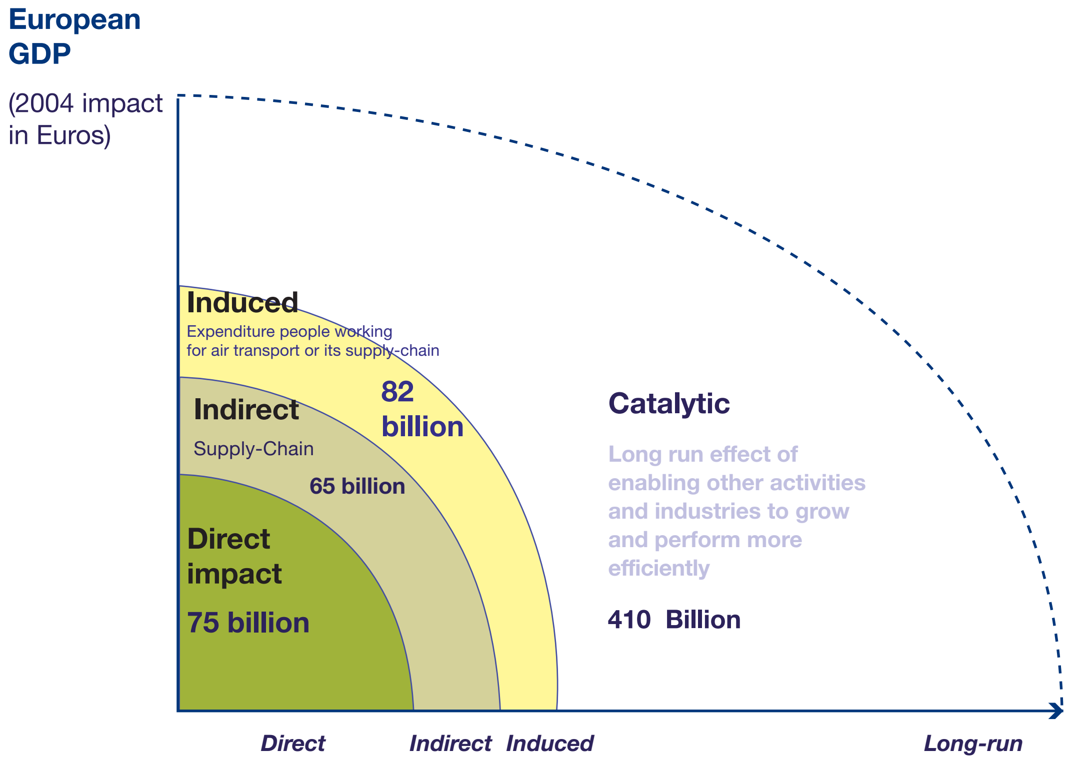



Figure 37: Aviation contribution to the European GDP in 2004

Catalytic Effects of Air Transport in Europe - 2005). It also shows that air transport had in 2004 a long run effect delivering an additional €410Bn through its catalytic and dynamic effects to the rest of the European economy. The catalytic effects of aviation are brought through the provision of opportunities for business investment as more flights encourage more businesses to locate or expand in a region, labour mobility, widening of markets, increased competition, more innovation, transfer of technology and increased productivity. Not considering the catalytic effects, air transport has the potential, based on the economic forecast, to contribute in 2020 €470Bn. If airports' capacity fails to meet demand, there could be a potential yearly loss to Europe of about Euro €50Bn of added value in 2020. The number of jobs enabled by air transport considering the direct, indirect and induced impacts was estimated to be already 4 million in 2004 with an additional 1.5 Million in 2025.

**Safety** is a design driver since any capacity increase shall not deteriorate the Safety level. The economic benefits from Safety are associated with the accommodation of more traffic. An overall detailed assessment of safety impact is not possible at this stage, however an initial qualitative assessment indicates that the Master Plan implementation will have the potential to increase the level of Safety in relation to the traffic growth as the majority of the operational improvements in the ATM Target Concept have a positive contribution to safety. Early deployment of specific initiatives like runway incursion prevention, improved performance of the safety nets will have a direct positive effect on safety. Additional safety benefits are foreseen with the introduction of new communication, navigation and surveillance technologies, providing better access to information and enabling the position of every aircraft (including GA) and vehicle to be electronically visible to other users of the system. Further investigation is needed in the next phases to assess the extent of the potential safety benefits.

Efficiency gains through the stepwise implementation of ATM Target Concept will directly reduce the **Environmental** impact of every vehicle movement in European Airspace and at European Airports. The enhancements in air traffic management through the optimisation of horizontal and vertical flight profiles have the potential to trim down the in-flight CO2 emission cumulated over the 2008 to 2020 period with around 50 Million Tons. Initiatives such as CDA/Green approaches will, in areas where noise and environment around populated areas is an issue, improve local air quality and minimise duration and intensity of noise exposure in the TMA. At the airport, reduction will be achieved through the expansion of best "practices" (e.g. reduction of taxi and holding times) and integrating the airport collaborative environment management process in the ATM network.

In addition it is recognised that close cooperation with major initiatives such as CleanSky will further enhance the environmental benefits for society.

## 4.2 Operational Benefits

Specific targets per KPA have been set for the 2020 ATM Target Concept (see section 9.4). This chapter presents the assessed operational benefits from its implementation. They contain the cost effectiveness and capacity, including the Quality of Service KPAs expressed in efficiency and predictability. In addition to the quantifiable benefits some additional qualitative benefits have been identified. It needs to be stressed that the figures are a result of an initial assessment, which requires further validation during all the phases of the Master Plan life cycle.

### 4.2.1 ANS Provider Cost effectiveness

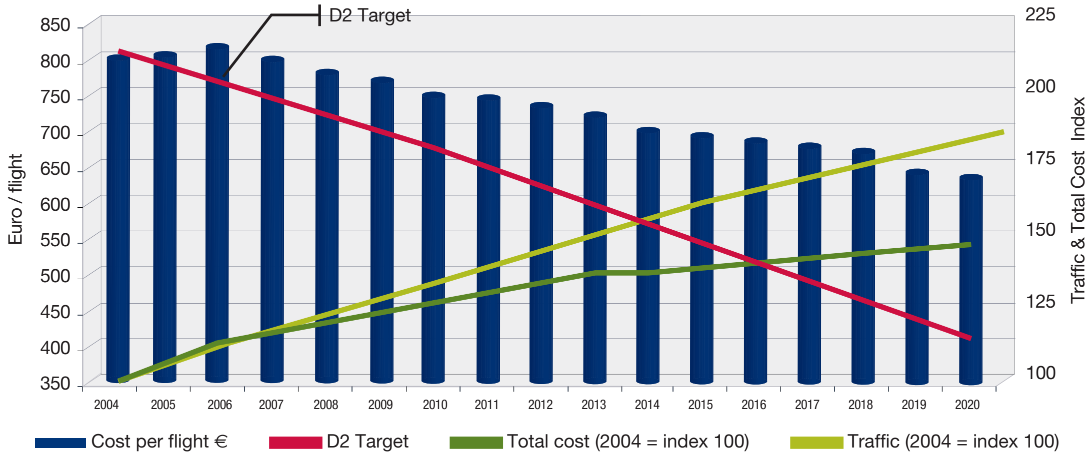
**The Master Plan implementation will contribute to reaching the Cost Effectiveness target that aims at halving the direct ATM cost per flight.** As Figure 38 shows, current calculations indicate a gradual reduction up to a level of €630/flight (ECAC average) by 2020. This represents a contribution of 42% of the target €400/flight unit cost reduction. This is achieved by introducing operational improvements to increase the ATCO productivity rather than the traditional way of adding sectors and associated staff when traffic increases[13]. The investments to improve the performance of the system are mainly for the introduction of advanced automation tools and the provision of better information for the controller to execute his tasks and responsibilities e.g. decision making, monitoring, coordination, remote control and use of advanced navigational capabilities of aircraft, better quality of planned traffic through SBT refinement and agreement (SWIM and data sharing).

Figure 38, over the 2008-2020 period, the savings due to direct ATM cost per flight reduction will deliver a benefit of around €8Bn for the commercial airlines.

The SESAR consortium is expecting additional initiatives external to the scope of the SESAR programme but within the framework of the Single European Sky in order to contribute further to the remaining portion of the initial Cost Effectiveness target and to deliver an additional unit cost reduction of €230/flight. **However the potential effects of these initiatives have not been assessed by the SESAR Consortium since they are outside the scope of the SESAR Definition Phase.**

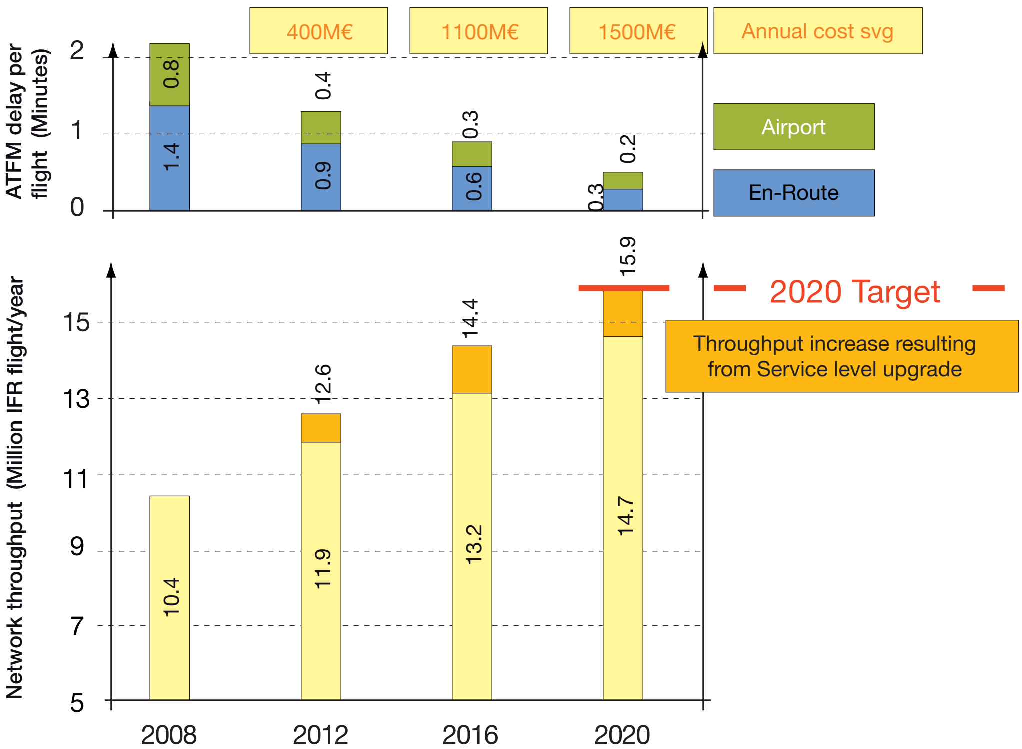
Improved staff productivity and resulting costs per flight remains the main driver behind unit cost reductions. A major driver will be the technical ability of the ATM Target Concept to support FAB implementation and technical de-fragmentation, the exploitation of

[13] The effect on ATM operating cost due to the lessening of the number of ATCO when traffic increases is multiplied by its influence on investments and operating costs: land and building, systems procurement, support staff and administration staff recruitment




| Cost Effectiveness | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|
| Average cost per flight (€) | 780 | 715 | 670 | 630 |
| TOTAL ANS cost per year (€Bn) | 8.1 | 9.0 | 9.6 | 10.0 |
| **Total cost savings** (€Bn) | ← € 8 Bn → | | | |

Figure 38: Evolution of the ATM unit costs per flight




| Capacity / Delay | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|
| Average AFTM delay per flight (min) | 2.2 | 1.3 | 0.9 | 0.5 |
| **Total benefits savings** (€Bn) (Capacity gain & Delay reduction) | ← € 9 Bn → | | | |

Figure 39: Network throughput and delay development from 2008 to 2020

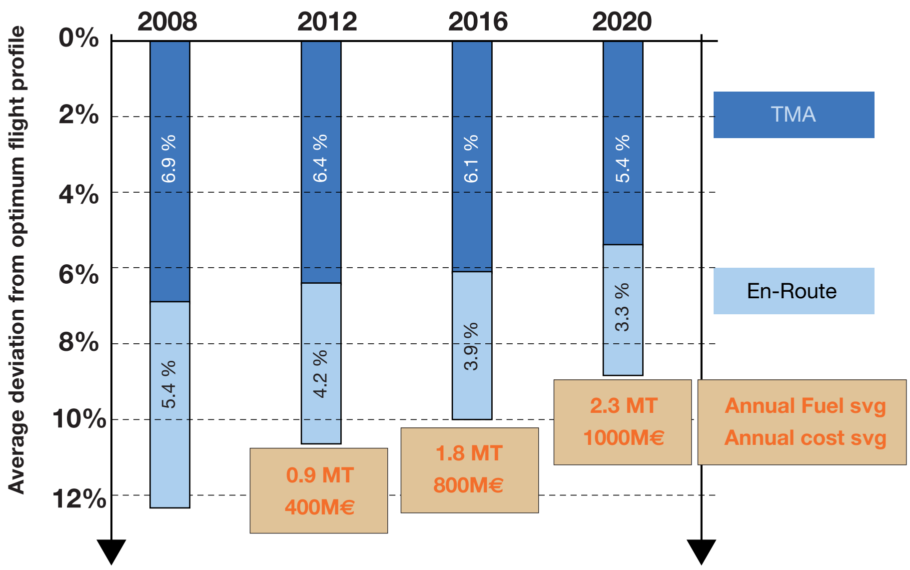
synergies between ANS Providers, plus more ambitious consolidation plans, and the co-ordination of initiatives at European level (e.g. rationalisation of CNS aids, generic validations).
No substantial reduction in ATM cost per flight could be achieved through financing initiatives since the present system of full cost recovery remains.

### 4.2.2 Capacity and Quality of Service

Assessment of the ATM Target Concept indicates that it should allow the network throughput target of 16 Million IFR flights set in Chapter 2 (representing a +73% increase from 2005 at the ECAC network level) to be accommodated in 2020 with acceptable Quality of Service. Average ATFM delay decreases from more than 2 minutes in 2006 to about 0.5[14] minute in 2020. While the need to move to the SESAR D2 indicators for departure delay is recognised, the ATFM delay has been selected as indicator of the QoS, being the only one for which current values and models are available.

The ATM Target Concept increases **En-Route Capacity** by approximately 70% (2020 vs. 2005) in High Density Airspace that would decrease the En-Route average ATFM delay from 1.3 minutes in 2005 to 0.3 minutes in 2020.

The ATM Target Concept increases **TMA Capacity** by approximately 40% (2020 vs. 2005) in High Density TMA, which is likely not sufficient for meeting the QoS targets at the 10 most congested TMAs in Europe. Note that this potential TMA shortfall is not fully included in the En-Route ATFM delay assessment because of the lack of TMA capacity forecasts without SESAR. The 2020 En-Route ATM delay might be slightly higher than 0.3 minutes.
The Master Plan implementation enables doubling the cumulated Airport throughput at Network level: around 75% through rolling out of "best in class" practices, 10% from already planned infrastructure development and 15% through enhancement of best in class performance which would have to deliver further airport capacity gains at individual Airport level in order to achieve the Airport capacity targets defined in section 2.1.1. However, due to the traffic distribution, an increased number of airports will become congested with the current airport development plan. These congested airports are not necessarily located in the top 10 congested identified TMAs. Without enhancement of "best in class" performance, the 2020 annual airport throughput would be about 1 Million Flights less.
The benefit, as depicted in Figure 39, is monetised based on the capacity gain and the departure delay savings leading to a total of €9Bn benefit over the 2008-2020 period for the commercial airlines, and to an additional €10Bn savings of Passenger Travel Time[15].




| QoS Fuel Efficiency | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|
| Deviation from optimum (% total) | 12.3% | 10.6% | 10.0% | 8.7% |
| Fuel savings per flight (kg) | | 70 | 130 | 140 |
| **Total fuel savings** (Mt Fuel) | ← 17 Mtonnes → | | | |
| **Total cost savings** (€ Bn) | ← € 8 Bn → | | | |

Figure 40: Fuel efficiency savings from 2008 to 2020

[14] In D4, the average ATFM delay was estimated at 1.2 minute in 2020 (0.5 En-Route and 0.7 Airport). This estimation has been updated in D5 since the inputs used during the D4 for Airport Capacity improvement and Airspace Capacity in medium density airspace were not correct. This estimated average ATFM delay does not include weather or special events related delays.
[15] SESAR benefit monetised based on CBA standard values: Additional flight=€700, one minute of delay=€35, Passenger value time = €40 (per minute of delay)

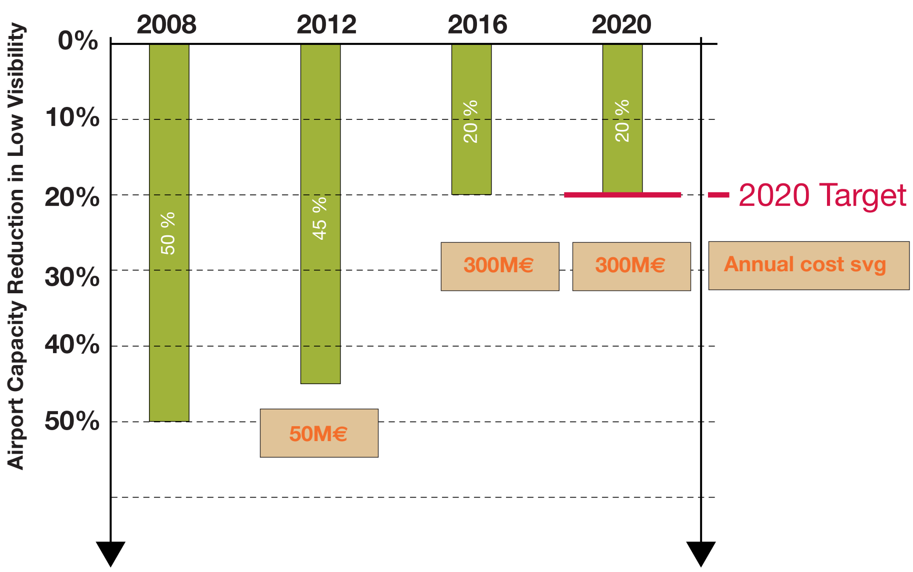
The ATM Target Concept reduces the deviation from the optimum gate-to-gate flight profile from 12.3% (2008) to 8.7% (2020). This flight Efficiency gain will allow in flight Time Efficiency savings (not quantified) and significant savings in flight Fuel Efficiency. As illustrated in Figure 40 the benefits will be close to 17 Millions Tons of fuel over the 2008-2020 period, representing a monetary value of about €8Bn indirect cost savings over the period 2008-2020 (with fuel price at 0.54US$ per kg and 1 US$ exchange rate at €0.77). Further research on operational improvements with the potential to reduce more the deviation from the optimum profile is however required.

Further research on operational improvements is required with the potential to significantly reduce the deviation from the optimum profile.

The Fuel Efficiency savings will also reduce gaseous emission and thus will constitute significantly to the Environment Sustainability KPA (see section 4.1).

The ATM Target Concept improves the Predictability through a better planning and queuing process based on a better information management. This better information management is also aimed at improving the decision making process allowing the ATM system to become more resilient against unpredictable events. However these benefits have not been quantified except for Predictability improvement in case of low visibility conditions. The operational improvements have been assessed on their contribution to a reduction in the capacity gap in low visibility situations. If the target of 20% in 2020 is met, it would result in about €2Bn indirect cost savings over the period 2008-2020 for the commercial airlines and equally a €2.5Bn savings of Passenger Travel Time (see Figure 41).

The ATM target concept improves the Flexibility by a more collaborative approach during the pre-tactical and tactical phases based also on better information management geared to improve the decision making process.




| QoS Low Visibility | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|
| Capacity reduction (%) | 50% | 45% | 20% | 20% |
| Flight cancellation (%) Equivalent Ratio | 0.16% | 0.15% | 0.08% | 0.08% |
| Total cost savings (€Bn) | ← € 2 Bn → | | | |

Figure 41: Low visibility savings from 2008 to 2020

## 4.3 Further benefits

An overall assessment of the operational ATM Target Concept and the planned operational improvements indicated some initial qualitative improvements in these specific areas towards their objectives as shown in the following Table 2.

| KPA | Benefits |
|---|---|
| Access and Equity | Transition from present airspace classification to two categories of airspace with services tailored to the users' specific capability levels. |
| Participation | Effective participation and active involvement of the European Civil Aviation Community, including trade unions and professional bodies, within the SESAR JU activities, will enable proactive identification of social and change risks and opportunities towards the common goal to improve the overall performance of the ATM system |
| Interoperability | The economic viability of the ATM system concept has a significant dependency on the attainment of a sufficient degree of interoperability, which is best regarded as an enabler. |
| Security | Improved self protection against security incidents & recovery from security incidents |
| Flexibility | Better information and coordination improves the decision making process to become more resilient against randomly occurring unpredictable events. |

Table 2 Initial benefits for specific KPAs

## 4.4 Required Investment and Financing

In addressing the financing and investment aspects, the following needs to be noted:

During the Definition Phase it was determined that commercial airlines and airports did not require a specific financial plan for the Master Plan implementation investment as cost information and a positive CBA is considered as sufficient for their decision making. They will develop these financial plans by their own, considering also that the investments have to be integrated in their overall investment plan to sustain the Air Transport growth. Therefore financing and funding scenarios were not carried out for these stakeholders.

For the Military, it was not possible to carry out a complete CBA and financing analysis due to problems of quantifying the benefits, the outcomes of which could show that they might be unable to fund the total cost without Commission/States grants.

For BA and GA it was not possible to carry out a complete CBA and financing analysis due to the lack of significant benefits (besides safety) and/or difficulty to quantify some benefits. However, analyses so far indicate that CBAs for BA and GA are likely to be negative. If further work confirms this, ways of support to financing BA and GA equipage must be found.

Coordinated procurement is assumed to a certain extent in the current cost assessment. An uncoordinated approach will create the risk of an increase of the investment by 5-15%. This could be facilitated through a coordination entity, which also could take the benefit arising from the deployment of parallel ATM programmes such as NextGen.

The concept of a possible own financing entity or joint procurement structure for the Master Plan implementation investment program either for one or a group of stakeholders was not supported by the stakeholders.

### 4.4.1 Stakeholders investments

#### 4.4.1.1 Stakeholder cost summary

The total estimated investments and operating costs for the Users, Airports Operators and ANS Providers to achieve ATM Capability Level 3 is around €30Bn. Figure 42 and Table 3 provide a breakdown of the total investments and the investments over time per stakeholder.

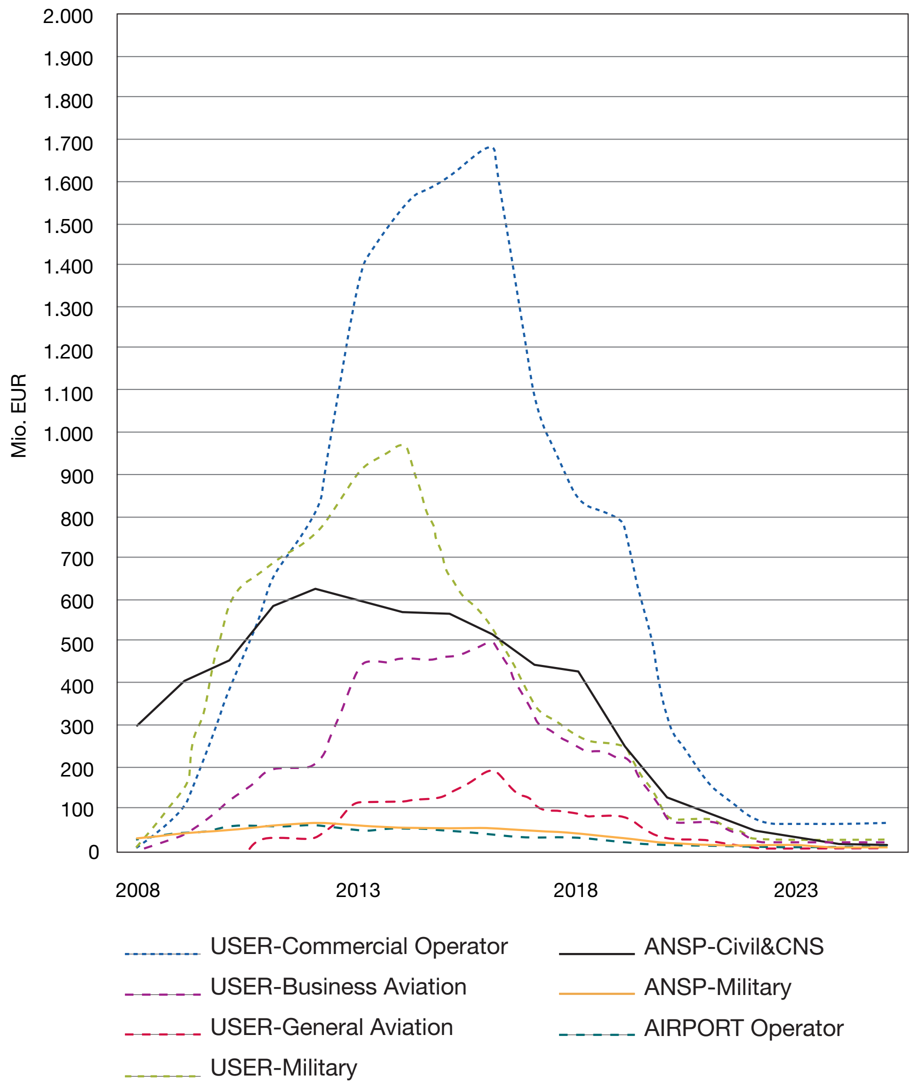



Figure 42: SESAR Investment per stakeholder per time to achieve ATM capability level 3

Stakeholders SESAR Investment Overview Capability Level 1-3 (in M€)

| Description | | User - Comm. Operator | User - Business Aviation | User - General Aviation (1) | User - Military | ANSP - Military | ANSP Civil & CNS | Airport Operator | Total Investment (M€) |
|---|---|---|---|---|---|---|---|---|---|
| Cap.level | 1 | 2,130 | 650 | 940 | 3,330 | 240 | 2,560 | 300 | **10,150** |
| | 2+3 | 9,400 | 2,740 | 0 | 3,060 | 330 | 3,660 | 250 | **19,440** |
| TOTAL | | **11,530** | **3,390** | **940** | **6,390** | **570** | **6,220** | **550** | **29,590** |

(1): User IFR Capable GA (except BA) and User VFR Only GA costs are to retrofit to Capability Level 1.
However, as shown in figure 39, these costs are incurred mainly in the period from 2013 to 2020.

Table 3 Stakeholders SESAR Investment overview

#### 4.4.1.2 Users costs

Users costs have been computed (see Table 4) based on the evolution of the number of aircraft per stakeholders which are affected, and on the definition of avionics packages to be (retro)fitted to reach the successive Capability Levels. The investments differentiate between structural and incidental avionics packages whereas structural packages are fitted in all aircrafts while incidental packages represent individual stakeholder equipage needs for specific operational environments (e.g. HUD/EVS - positive CBA dependent).
In the current costs assessments, avionics packages are assumed to become "basic" (part of some standard aircraft) after a certain period of time (approximately 7 years).
For all capability levels it has been determined that the estimated retrofit costs represent approximately twice the costs of the forward fit. Further analysis of the detailed solutions to deploy the ATM Target Concept should consider the viability of having 2 different solutions for the same function on board commercial aircraft:

- The "nominal" fully scoped ATM Target Concept solution for forward fit;
- A "minimum" solution at a lower cost (especially for old aircraft for which a limited retrofit might happen in the future).

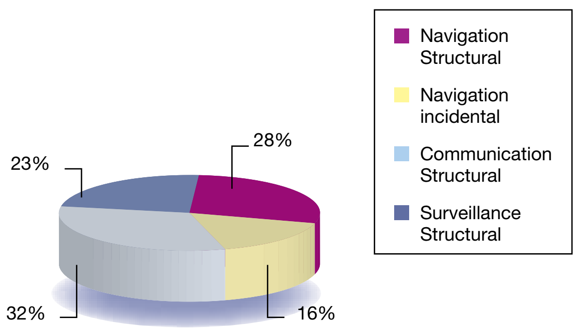
| Description | | | Retrofit | | | | | Forward Fit | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Commercial | BA | GAI FR | GAV FR | MIL | Commercial | BA | MIL | |
| Cap level 1 | # A/C | | 3,690 | 1,200 | 13,631 | 91,920 | 7,562 | 3,710 | 900 | 1,467 | 124,080 |
| | cost per a/c | in k€ avg. | 382 | 330 | 29 | 6 | 383 | 195 | 280 | 293 | |
| | **total cost** | **in M€** | **1,410** | **400** | **390** | **550** | **2,900** | **720** | **250** | **430** | **7,050** |
| Cap level 2 | # A/C | | 4,140 | 1,680 | | | 7,562 | 4,010 | 1,170 | 1,467 | 20,029 |
| | cost per a/c | in k€ avg. | 854 | 590 | | | 370 | 455 | 650 | 136 | |
| | **total cost** | **in M€** | **3,540** | **990** | **0** | **0** | **2,800** | **1,820** | **760** | **200** | **10,110** |
| Cap level 3 | # A/C | | 4,515 | 2,280 | | | | 4,385 | 1,320 | | 12,500 |
| | cost per a/c | in k€ avg. | 620 | 310 | | | | 283 | 210 | | |
| | **total cost** | **in M€** | **2,800** | **710** | **0** | | **0** | **1,240** | **280** | **0** | **5,030** |
| TOTAL COST | | | **7,750** | **2,100** | **390** | **550** | **5,700** | **3,780** | **1,290** | **630** | **22,190** |

Notes:
The civil airspace Users avionics costs are based on the assumption of full global system Interoperability, e.g. with NextGen. Potential proliferation of technical solutions could result in significant cost increase.
GA foresees avionic costs only to retrofit and reach Capability Level 1; GA has done the cost assessment in the categories IFR and for VFR.
MIL Investments for Capability Level 2+3 are not separated, therefore have been allocated in total to Capability Level 2 line

Table 4 Users number of aircraft, cost per aircraft and total cost

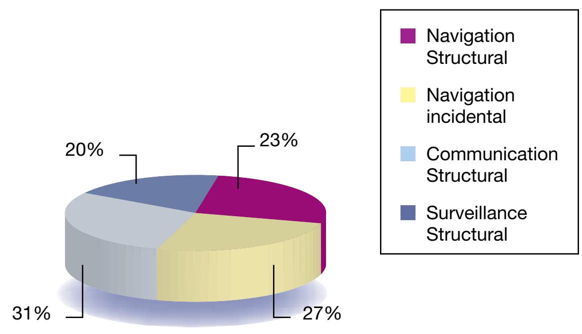
Figure 43 and Figure 44 show a split of the avionics costs to achieve the required aircraft CNS performance.

The additional one-off cost (e.g. training) and operating ground costs are considered to be covered in the budgets of each stakeholder and their values are shown in Table 5 and Table 6 respectively.




Base: Invests Commercial Operator M€11.530

Figure 43: Division of commercial operators airborne equipage costs in CNS functionality




Base: Invests Business Aviation M€3.390

Figure 44: Division of business aviation airborne equipage costs in CNS functionality

| Description | | Commercial | BA | GA IFR | GA VFR | Military | Total training (M€) |
|---|---|---|---|---|---|---|---|
| Cap. Level | 1 | **0** | **0** | **220** | **570** | **0** | **790** |
| | 2 | 170 | 10 | | | 60 | 240 |
| | 3 | 190 | 10 | | | | 200 |
| | 2+3 | **360** | **20** | | | **60** | **440** |
| TOTAL | | **360** | **20** | **220** | **570** | **60** | **1,230** |

Table 5 Users additional training costs

| Description | | Commercial | BA | GA | Military | Total training (M€) |
|---|---|---|---|---|---|---|
| Cap. Level | 1 | **4** | **0** | **0** | **n/a** | **4** |
| | 2 | 129 | 2 | 0 | n/a | 131 |
| | 3 | 128 | 2 | 0 | n/a | 130 |
| | 2+3 | **257** | **3** | **0** | **n/a** | **261** |
| TOTAL | | **262** | **3** | **0** | | **265** |

Note: User Operational Ground Costs are a mix of investments and additional operating costs

Table 6 Users operational ground costs

### 4.4.1.3 ANS Provider

**ANS Provider Civil, CNS Infrastructure Operator, Regional Network Manager and Regional Airspace Manager**

ANS Provider expenditures/costs (Table 3) have been computed based on the assumption that there will be one or two different industry developments for each subsystem improvement needed to reach the required capability levels and on the number of units (ACC, TWR, etc.) where the improvements will be deployed. Figure 45 provides a division of the costs per major ATM system.

Table 7 shows the costs of architecture and CNS systems per capability level.

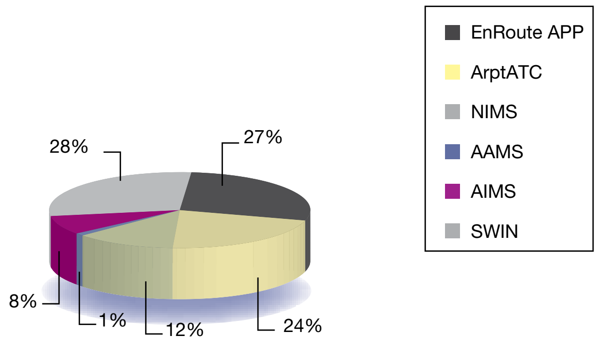



Figure 45: ANS Provider Civil - Architecture Investments

| Description | | Pre-Impl. (R&D/N.R) | Deployment + One-off Inv | Total Investment (M€) | One-Off (Training, Staff, Legisl.) |
|---|---|---|---|---|---|
| Arch. Cap. Level | 1 | 200 | 1,210 | 1,410 | 440 |
| | 2+3 | 950 | 1,670 | 2,620 | 440 |
| Subtotal | | **1,150** | **2,880** | **4,030** | **880** |
| CNS Cap. Level | 1 | 10 | 1,140 | 1,150 | 20 |
| | 2+3 | 100 | 940 | 1,040 | 20 |
| Subtotal | | **110** | **2,080** | **2,190** | **40** |
| Total | 1 | 210 | 2,350 | 2,560 | 460 |
| | 2+3 | 1,050 | 2,610 | 3,660 | 460 |
| **TOTAL** | | **1,260** | **4,960** | **6,220** | **920** |

Table 7 ANS Provider Civil & CNS investments

#### 4.4.1.4 ANS Provider Military

Table 8 shows the ANS Provider Military costs covering the required capability to manage OAT of the en-route ATM system to reach necessary capability levels. It does not include costs for evolution of the Local Air Defence systems as well as the NATO Air Command and Control System (ACCS), which will need to be adapted to the ATM Target Concept information management environment in order to remain interoperable and allow for the required information flow.

| Description | | Pre-Impl. (R&D/N.R) | Deployment | Total Investment (M€) | One-Off (Training, Staff, Legisl.) |
|---|---|---|---|---|---|
| Arch. Cap. Level | 1 | see deployment | 140 | 140 | 0 |
| | 2+3 | | 240 | 240 | 0 |
| Subtotal | | | **380** | **380** | **0** |
| CNS Cap. Level | 1 | see deployment | 100 | 100 | 0 |
| | 2+3 | | 90 | 90 | 0 |
| Subtotal | | | **190** | **190** | **0** |
| Total | 1 | | 240 | 240 | 0 |
| | 2+3 | | 330 | 330 | 0 |
| **TOTAL** | | | **570** | **570** | **0** |

Table 8 ANS Provider Military investment

#### 4.4.1.5 Airport Operator

Table 9 shows the Airport Operator Civil costs related to the evolution of the management of the airport systems, e.g. "stand and gate management", and associated information systems - e.g. SWIM/NIMS (ATC system improvements are covered in the ANS Provider civil and CNS costs).
They take into account the 150 airports[16] affected by the Master Plan implementation, classified in two classes on the basis of the number of movements per year (large/medium, or small) for which different types of improvements are implemented to reach the successive capability levels.

The majority of airport infrastructure such as new runways, terminals, rapid exit taxiways or aprons is outside the Master Plan scope and have not been considered, but are essential enablers to obtain the benefits from the deployment of the Master Plan. Also costs for ground-handlers have not been included.

| Description | | Pre-Impl. (R&D/N.R) | Deployment | Total Investment (M€) | One-Off (Training, Staff) |
|---|---|---|---|---|---|
| Arch. Cap. Level | 1 | 40 | 230 | 270 | 20 |
| | 2+3 | 10 | 70 | 80 | 10 |
| Subtotal | | **50** | **300** | **350** | **30** |
| CNS Cap. Level | 1 | 3 | 20 | 23 | 1 |
| | 2+3 | 50 | 120 | 170 | 4 |
| Subtotal | | **53** | **140** | **193** | **5** |
| Total | 1 | 43 | 250 | 293 | 21 |
| | 2+3 | 60 | 190 | 250 | 14 |
| **TOTAL** | | **103** | **440** | **543** | **35** |

Table 9 Airport Operator investment

Estimation of the cost of Military Organisations as Airport Operator Military, i.e. operators of civil-military airports, has not been pursued since it is assumed that the Master Plan implementation related investments required on civil-military airports in principle would be borne by the Airport Operator Civil operator.

16 This results from the assessment made of the number of airports to improve for accommodating the target of around 7300 movements per hour in Europe by 2020.

## 4.4.2 Cost Benefit Analysis (CBA)

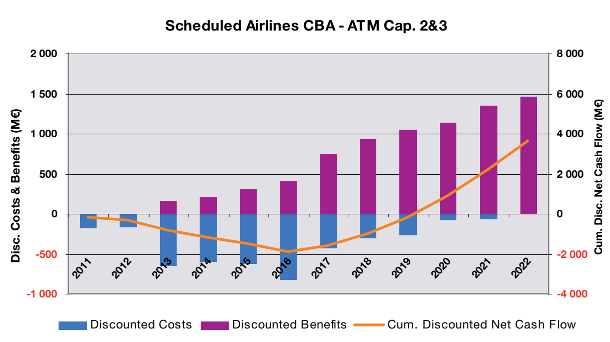



Figure 46: Initial CBA analysis for commercial airlines

Figure 46 shows the Master Plan implementation Cost Benefit Analysis (CBA) results for User Commercial Operators. The transition from ATM Capability level 1 to ATM Capability level 3 shows a positive CBA result with a break even point in 2019. This is acceptable for such a strategic investment. However, the cumulated net cash flow highlights the high upfront avionics investment required of around €2.0Bn during the 2015-2017 period. As a consequence, some airlines might decide to postpone their investments, which would delay the benefits expected at the ATM Network level or prevent them to materialise.

The deployment sequence of the 2020 target concept goes towards a viable direction but further enhancements are necessary. Further refinements, possible adjustments of the Master Plan and setting priorities for the introduction of the operational improvements should aim at shortening the payback period. The risk identified needs to be carefully monitored.

For the Military, CBA computations started during SESAR Definition Phase will have to be pursued with better estimation of their benefits and consideration of their role as User, ANS provider and Airport operator.

## 4.4.3 Funding and Financing Aspects of the ATM system deployment

### 4.4.3.1 Funding and financing of the ATM system deployment

The ATM Sources of Financing and Funding are represented in Figure 47.

The present system of **funding** ANS costs through customer charges will remain the principal system of funding in Europe irrespective of the financing methods chosen.

1) En-Route & Terminal Air Navigation Services charges for Users: no major activities for changing this funding mechanism is currently underway. Some wider form of economic regulation may be required to set/agree targets for cost effectiveness improvements as identified in the SES "common charging scheme for ANS" (EC N° 1794/2006) and planned in the SES II legislation (economic regulation).

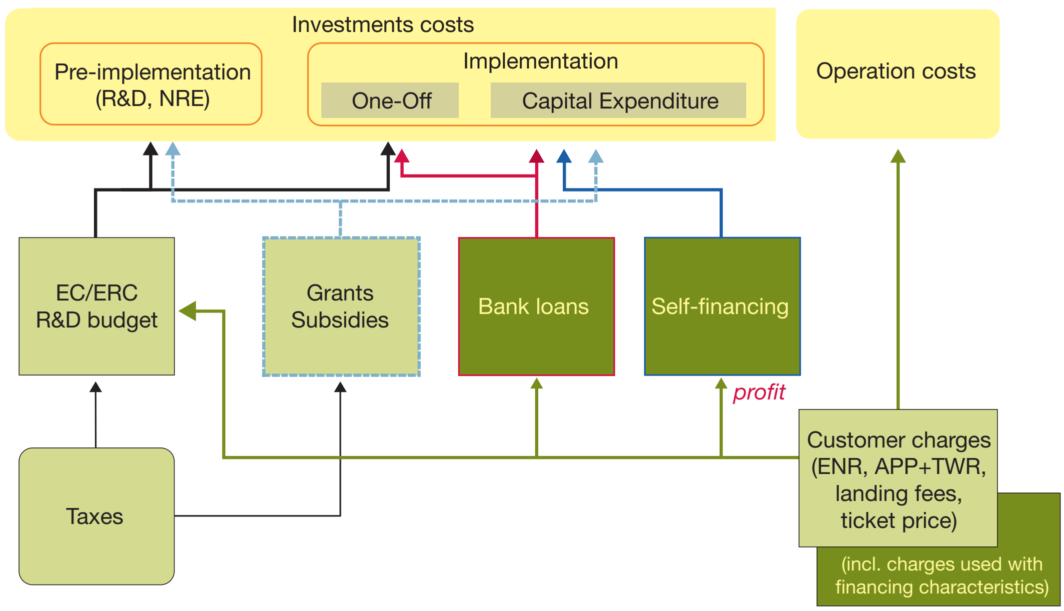



Figure 47: ATM sources of Financing and Funding



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2) Non repayable grants or subsidies: for the deployment phase any grant/subsidy element for the SESAR financing should be executable on a European level for the Master Plan investments, a method currently not available in the regulations.

3) Terminal Air Navigation Services charges for Users: at the moment, only political decisions can change the situation to address the users requirement for transparency in practices of Airport Operator cross subsidies.

For the Master Plan implementation investment, existing capital market **financing** methods are applied such as loans, leasing, equity, capital market interest, etc. In addition, the following financing methods might be considered:

1) In the ANS Provider cost effectiveness calculation, the amortization/depreciation of ANS Provider investments for Capability Level 2+3 have been delayed in a period after 2015 to contribute to the requested financing needs on the User side. This mechanism reflects a contribution to later benefit effects for investments in the time period 2013 – 2017 (Capability Level 2 investments on User side).

2) An alternative financing methodology is proposed to create an ATM stakeholders internal asset financing entity which prefinances part of the Master Plan implementation investment and lends them back to the operating entities.

#### 4.4.3.2 Financial incentives

History has shown that the implementation of ATM improvements tends to have long delays as different stakeholders (Users/ANS Providers/Airports Operators) invest at different speeds and in different sequence, therefore slowing down the realization of the benefits. This risk has been identified especially for the first peak investment time period between [2013 - 2017]. Incentives are a tool to attenuate these problems and facilitate the timely and coordinated implementation of ATM improvements. Specific attention should be given to stakeholders that need investments for capabilities not directly linked to their primary mission objectives (e.g. Military).
The following scheme and proposals shall therefore be studied in detail and appropriate solutions shall become effective not later than 2012.
A financial incentive scheme for the Master Plan implementation should be laid down at a multi-national or pan-European level for those improvements that are considered strategic and form the backbone of the ATM Target Concept. They should be developed in close consultation and collaboration between affected stakeholders, with a focus on ANS Providers, Airports Operators and Users from the start up to their implementation.
The ANS Providers and Airports Operators could set an average price decrease target per flight per year over 3 to 5 years forward for an agreed level of service. The new investments and improved technology and productivity would allow the efficient ANS Providers to meet the set targets. Those who manage to achieve higher revenue while meeting these targets would be allowed to retain the excess. Those who fail to fully recover the costs would have to finance it through other sources and renegotiate the targets for the next period. Similarly, Users, which are equipped and thus directly contribute to increase the network productivity and throughputs, would benefit from lower charges per flight. Those that are not equipped within the agreed timeframe or are forcing ANS Providers/Airports Operators to retain redundant systems would pay higher charges per flight. Aside from the differential charging principle, there are other potential incentives for Users as shown in Figure 48.

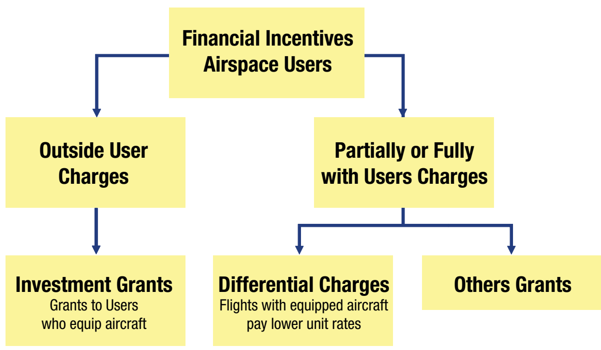


Figure 48: Types of Financial Incentives for Airspace Users

The possible incentive schemes need to be analysed in respect of their impact on costs, investment and implementation timeline and consider the following principles:

- An environment is necessary to reach a common position and agreement between Users, Airports Operators and ANS Providers;
- To meet the targets in the initial phase of the Master Plan implementation, cost/opportunity is subject to the present charging principles. Thereafter, differential pricing could be considered as an incentive for a pre-determined period and with periodic monitoring to evaluate the effectiveness of the incentive;
- Establishment of differential pricing or other incentive requires strict regulatory and/or an agreed economic independent supervision to ensure the system as a whole remains revenue neutral.

### 4.4.4 Next steps

An economic scheme needs to be established which addresses the commitment for investments for all stakeholders and the necessary cost and quality of service commitments for ANS Providers and Airport Operators to meet determined Master Plan implementation objectives.
This shall be developed as part of the Performance Partnership which reinforces the commitment for investment from all stakeholders to ensure collaboration in synchronous investment planning and measurement / evaluation of targeted benefit components as assumed in the CBA calculation on costs and quality of service in the planned time period.

# 5 Risk Management

Master Plan risk management addresses uncertainty associated with delivery of the ATM Target Concept. This includes meeting the required performance targets, as well as providing business benefits in a timely manner to all stakeholders. Risk management supports decision making and the overall aim of achieving agreement across all organisations that the Master Plan is the basis for the further work which will ultimately form the first part of the SESAR implementation phase.

Putting this into the context of achieving buy-in, Figure 49 characterises in a positive manner the main events, which must happen for stakeholders (including professional bodies) to have confidence that the Master Plan will deliver positive change and net benefit, and agree on the actions, which must be undertaken to implement the ATM Target Concept.

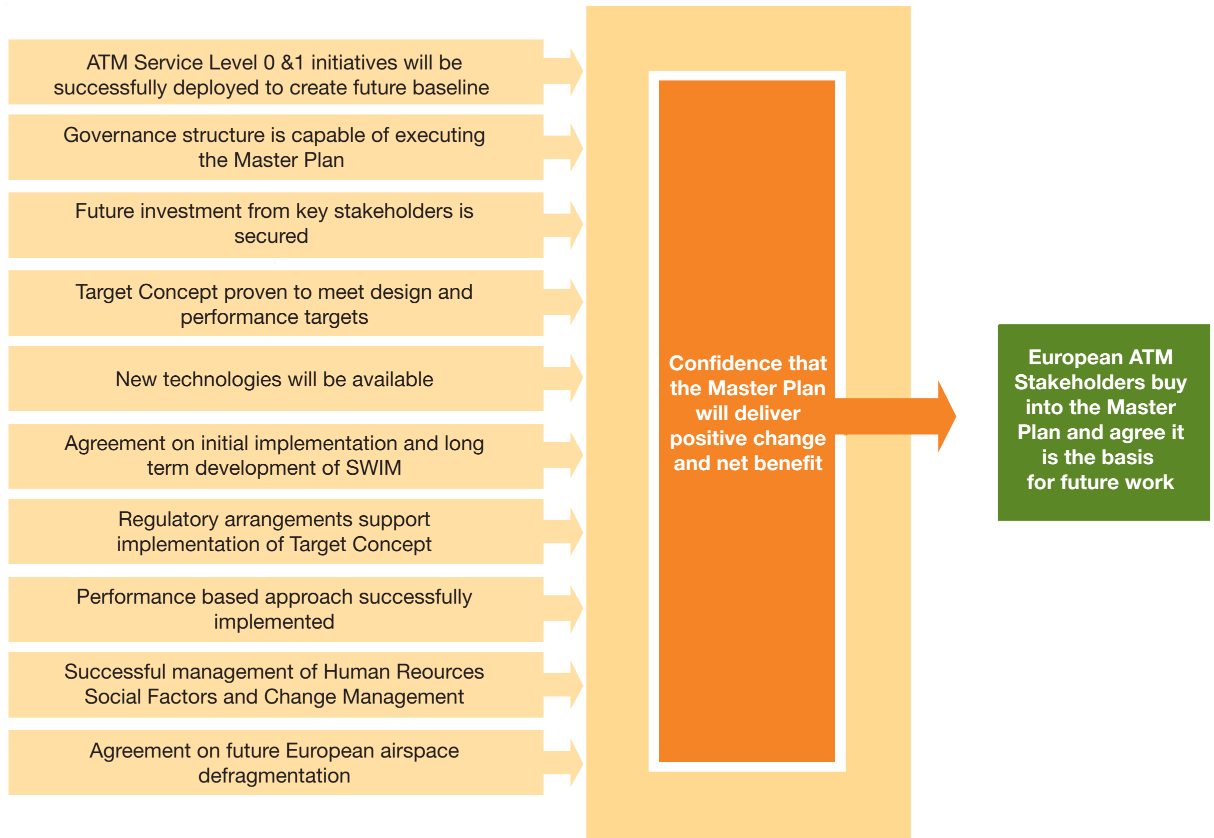


Figure 49: Factors Influencing Stakeholder Buy-in

Consequently, a risk to the Master Plan may be defined as an undesired event or a series of events, which reduce confidence in the Master Plan and, on occurring, may represent a potential obstacle towards delivering the Target Concept. Risks are treated through mitigation action plans to reduce the likelihood of the event materialising, thus increasing confidence and encouraging decision-making.

This chapter provides details of the key risks to the Master Plan following conclusion of the SESAR Definition Phase. It is highlighted that there is a clear need to continue the capture and communication of risk throughout the remainder of the project lifecycle, particularly the identification and management of those risks that may fall on the critical path. In addition the assumptions made to achieve the SESAR Definition Phase will be verified through further validation during the life-cycle phases of the Master Plan. Regular review and monitoring of risk mitigation activities will also be essential to ensure that actions plans remain current and actively contribute to reducing risk criticality.

## 5.1 Capturing and Analysing Risk

Risk capture has been a continual process in SESAR throughout the Definition Phase. Risks to the overall SESAR solution have been defined, assessed and mitigated following structured processes, and reviewed on a regular basis. Described here are the highest priority risks impacting the Master Plan whose scope extends beyond the SESAR Definition Phase.

The overall approach to risk management, illustrated in Figure 50, is based on standard processes, adapted to the SESAR Definition Phase. Priority was placed on risk identification, analysis and treatment planning and particular focus given to clearly defining the risk in terms of “Event”, “Cause” and “Outcome”. A more detailed analysis involving, for example, risk evaluation, risk recovery and contingency planning would have required more data than was available, but nonetheless this is highlighted as an important aspect of risk management to be considered during the SESAR Development Phase.

The methodology is further detailed in [Ref 12].

The probability of occurrence, but particularly the scale of the potential impact are the main factors in prioritising and determining the criticality of risks. In terms of impact of delay, it should be noted that a one year delay in ATM Service Level deployment would result in investment costs being spread over an additional one year period and that benefits are also delayed by one year. It has been estimated, using D4 DLM results, that this will result in extra costs of between €350M to €500M and a subsequent delay in the payback period of between 1 and 2 years.

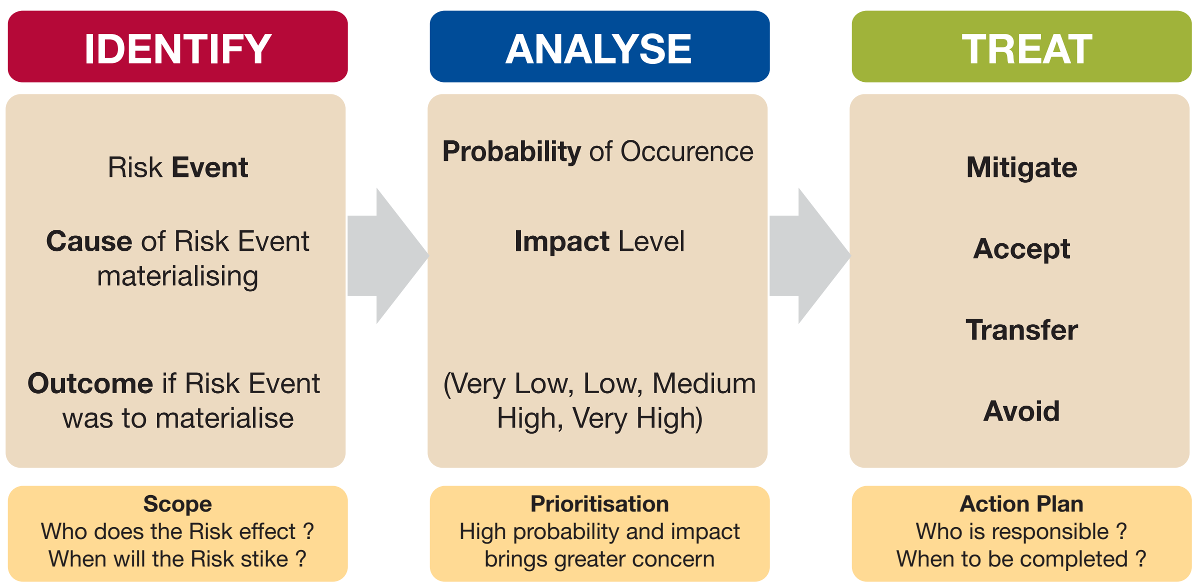


Figure 50 Risk Management Methodology

## 5.2 High Priority Risks

Figure 51 illustrates the highest priority risks, grouped according to their primary focus on ATM Service Levels 0 and 1 implementation, ATM Service Levels 2 to 5 development and implementation, and risks relating to institutional and management processes. These risks have been selected following analysis of the results from extensive risk capture activities involving representatives from all Stakeholder Groups participating in the Definition Phase (risk registers available in [Ref 12]).

It is recognised that there are very significant interdependencies between the selected major risks and that failure to successfully implement appropriate mitigation actions will inevitably result in risks emerging on the critical path. In particular, due to the time critical nature of ATM Service Level 0 and 1 deployment, and ATM Service Level 2 to 5 development, stakeholder alignment and commitment is essential.

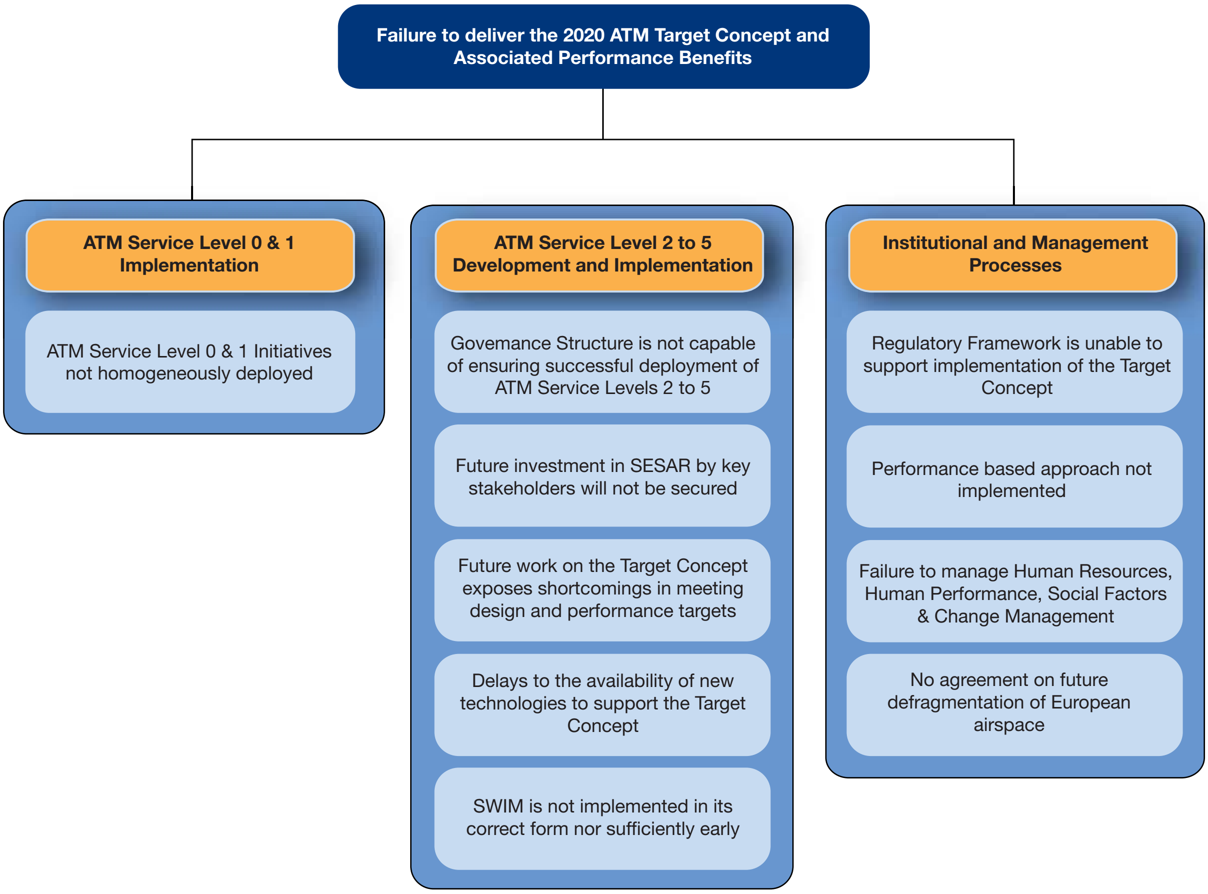


Figure 51: Highest Priority Risks

## 5.2.1 ATM Service Level 0 and 1 Implementation

The section below describes the main risk relating to ATM Service Level 0 and 1 implementation. It is considered that addressing this risk will go towards ensuring successful commitment to and deployment of ATM Service Level 0 and 1 initiatives as described in the Master Plan.

### 5.2.1.1 Non Homogeneous Deployment across Europe of ATM Service Level 0 and 1 Initiatives

The SESAR Consortium identified, as part of ATM Service Levels 0 and 1, a set of short term improvements available to create the foundation of future deployment resulting from the development work. Any delay or failure to implement these short term improvements on time will impact the rest of the ATM deployment sequence and will therefore jeopardise the implementation of the Target Concept.

This risk is considered to be one of the most critical risks to the project because failure to deliver ATM Service Level 1 benefits will jeopardise future investment, particularly that of airlines. It is described and assessed in Table 10, and mitigation actions proposed in Table 11.


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| Risk Event |
|---|
| Short term initiatives identified as necessary to deliver the required performances for 2013 (ATM Service Levels 0 & 1) are not deployed across Europe as described in the Master Plan |
| **Cause** |
| • Lack of political commitment (at state level) to ensure overall coordination of the short term initiatives<br>• Lack of appropriate governance and leadership for the implementation period<br>• Individual stakeholder plans for ATM Service Level 0 & 1 deployment are not aligned or not synchronised for example due to differentiated benefits at state level and subsequent local plan prioritisation |
| **Outcome** |
| • Delays in delivering performance benefits and reduction of expected benefits<br>• Potential duplication of efforts across Europe<br>• No implementation of quick wins to solve blocking points |
| **Probability** |
| High – Based on currently available information related to the implementation of the identified initiatives |
| **Impact** |
| Very high – Each year of delay will delay the performance delivery of the Target Concept by one year or endanger implementation of ATM Service Levels 2+ due to lost confidence in the benefits and subsequent decisions not to invest |

Table 10 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Establish appropriate governance and leadership functions for ATM Service Level 1 deployment | All Stakeholders | End 2008 |
| Implement performance based approach | All Stakeholders | End 2008 |
| Ensure continued proactive management of the buy-in of the short term initiatives by all Stakeholders (at all levels) | EC/ EUROCONTROL | End 2008 |
| Develop the communication mechanisms to ensure all actors are aware of the consequences of delaying ATM Service Level 1 | EC/ EUROCONTROL | 2009 – 2010 |
| Optimise the prioritisation and development timescales of the required Implementing Rules and revise Master Plan accordingly | EC / SESAR JU | 2009 – 2010 |
| Ensure adequate funding and correct mechanisms for incentives | All Stakeholders (including SSC and ICB) | 2009 – 2010 |
| Organise participation of all Stakeholders in the “Deployment” decision making process | All Stakeholders (including SSC and ICB) | 2009 – 2010 |
| Master Plan and Work Programme to be regularly updated taking in to account the consolidated needs of all stakeholders, which allows for the possibility for regions with early needs to accelerate implementation | SESAR JU / EUROCONTROL | End 2009 |
| Ensure and monitor consistency with acceptance of the Master Plan and consequently take the required actions to align business plans with the Master Plan | All Stakeholders | 2009 – 2010 |

Table 11 Mitigation Actions

## 5.2.2 ATM Service Level 2 to 5 Development and Implementation

The sections below describe the main risks relating to ATM Service Level 2 to 5 development and implementation. It is considered that addressing these risks will go towards ensuring successful stakeholder participation and commitment to the Development Phase and beyond.

### 5.2.2.1 Governance Structure is Not Capable of Ensuring Successful Deployment of ATM Service Levels 2 to 5

Successful execution of the Master Plan relies upon complex governance structures and the collaboration of many stakeholders. Although it principally affects ATM Service Level 2 to 5 implementation (i.e. 2013 onwards), early mitigation is essential. This risk is described and assessed in Table 12, and mitigation actions proposed in Table 13.

| Risk Event |
|---|
| The future governance structure is not capable of ensuring the successful deployment of ATM Service Levels 2 to 5. |
| **Cause** |
| • Lack of network user (Users, ANS Providers and Airport Operators) empowerment to take ownership of the deployment programme<br>• Lack of accountability between the various actors. |
| **Outcome** |
| • Timely decisions cannot be made on the investments needed |
| **Probability** |
| High – SESAR Definition Phase has been first step in bringing stakeholders together but significant work remains to ensure continued collaboration |
| **Impact** |
| Very High – SESAR will fail if governance structure cannot successfully execute the Master Plan |

Table 12 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Ensure a new ATM governance structure is put in place as recommended by the High Level Group Report | EC and EUROCONTROL in cooperation with network users | End 2010 |

Table 13 Mitigation Actions

### 5.2.2.2 Future Investment in SESAR by Key Stakeholders will Not be Secured

The feasibility of the SESAR implementation will be severely jeopardised if stakeholders are discouraged from investing. Airspace Users have long payback periods and dependencies on other stakeholders, while investments in technology development will not take place if there is no significant commercial return through customer sales. This risk is described and assessed in Table 14, and mitigation actions proposed in Table 15.

| Risk Event |
|---|
| Future investment in SESAR (e.g. to meet equipment and infrastructure requirements) by key stakeholders will not be secured |
| **Cause** |
| • Even if CBA is positive, benefits are too back-end weighted<br>• Expected benefits from ATM Service Level 1 implementation are not produced<br>• High sensitivity in benefit delivery pushes break even point fatally to the right<br>• Overall costs exceed the available budget<br>• Affected stakeholders are not properly involved in decision making during the Development Phase |
| **Outcome** |
| • Insufficient financial resources and investment<br>• SESAR fails and return to business as usual<br>• Many of the performance gains forecast for ATM Service Levels 2 to 5 threatened |

| Probability |
|---|
| Very High – Based on outcome from Definition Phase |
| **Impact** |
| Very High – SESAR will fail if investment from all stakeholders is not secured |

Table 14 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Ensure that High Level Group recommendations are implemented, service provision is restructured, and the future institutional framework supports the network users' deployment of SESAR | EC | Mid 2009 |
| Ensure close coordination between R&D activities and performance targets | SESAR JU | Ongoing Process |
| Ensure that all affected stakeholders are involved in the Master Planning process, not just consulted | SESAR JU | End 2008 |
| Ensure a more equitable sharing of risk between Airspace Users and ANS Providers and explore new funding mechanisms | EC | End 2008 |

Table 15 Mitigation Actions

#### 5.2.2.3 Future Work on the Target Concept Exposes Shortcomings in Meeting Design and Performance Targets

The SESAR Consortium identified a very ambitious and challenging ATM Target Concept in response to the ever increasing expectations for air transport. The Master Plan recognises that further work is required during the SESAR Development Phase to address the uncertainties over delivering the ATM Target Concept including, for example, addressing the "open issues" which remain following development of the ConOps during D3. This risk is described and assessed in Table 16, and mitigation actions proposed in Table 17.

| Risk Event |
|---|
| Results of future development and validation of the ATM Target Concept expose shortcomings in meeting the required design and operational performance targets |
| **Cause** |
| • Insufficient focus on Concept elements critical to providing expected benefits<br>• Concept does not focus sufficiently on congested areas of Europe<br>• Concept does not deliver improved performance in adverse weather conditions<br>• Lack of integration of the Performance based approach into Concept development |
| **Outcome** |
| • Future European ATM system will not deliver required performance improvements<br>• Rework required resulting in delays and increased costs, or potential compromise on performance |
| **Probability** |
| Medium – Based on progress made during D3 but it is recognised a number of open issues remain |
| **Impact** |
| Very High – Significant impact to meeting the D2 Performance Targets |

Table 16 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Perform validation activities at an early stage to identify from the start critical Concept elements to allow the proper planning of the R&D activities | SESAR JU | End 2009 |
| Ensure validation exercises are monitored by affected and supportive stakeholder representatives (including, if appropriate, military and GA) to ensure that any concept is afforded its best opportunity to prove its worth | SESAR JU | Ongoing Process |
| Ensure that the Concept and associated R&D initiatives are updated in the event that solutions/research do not sufficiently contribute to achieving performance targets | SESAR JU | Ongoing Process |

Table 17 Mitigation Actions

### 5.2.2.4 Delays to the Availability of New Technologies to Support the Target Concept

The ATM Target Concept has identified solutions that will require the introduction of new technologies. However, the Master Plan recognises that it has been challenging to select final technical enablers to date. Uncertainty over future technology choices and subsequent delays to technology or sub-system availability may adversely affect commitment to the Development Phase. This risk is described and assessed in Table 18, and mitigation actions proposed in Table 19.

| Risk Event |
|---|
| The availability (in terms of time, cost and performance) of new technologies to support the ATM Target Concept will be delayed |
| **Cause** |
| • Technology and sub-system development based on incorrect/unclear system requirements due to late availability of detailed ATM operational requirements<br>• The Development Framework proposed under D6 is unable to manage the R&D activities to ensure timely delivery of the right products and solutions to meet the business needs of the users of the network<br>• A lack of prioritisation of the R&D activities leading to spending money on projects that do not directly contribute to improved ATM performance<br>• The technology available in the required timeframe does not meet the expected ATM performance requirements<br>• The technology requirements lead to unaffordable solutions |
| **Outcome** |
| • Unable to realise elements of the Target Concept according to the planned schedule due to delay in deploying necessary supporting technology |
| **Probability** |
| High – Based on the results of architecture and technology work performed during the Definition Phase |
| **Impact** |
| Medium – Delay to implementation of Target Concept, but not necessarily non-compliance |

Table 18 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Ensure that R&D activities develop mature requirements to enable timely development of ATM sub-systems, selection and implementation of the right technologies | SESAR JU | Ongoing Process |
| Establish processes for coordination of R&D and standardisation, and proactively manage and finance development of standards through European standardisation bodies | SESAR JU and Regulatory & Standards Framework | End 2008 |
| Provide early definition of performance requirements and assessment of future technology capabilities | SESAR JU | End 2008 |

Table 19 Mitigation Actions

#### 5.2.2.5 SWIM is Not Implemented in its Correct Form nor Sufficiently Early

SWIM is an enabler of end-user applications needed in ATM and is required for extensive information sharing between all partners in the ATM system. The deployment of SWIM should start as soon as possible and continue throughout all ATM Service Level implementation.

The risk affects all ATM users because the ATM Target Concept relies on shared information throughout the totality of the system in order to be effective and efficient. Late or inadequate implementation of SWIM will adversely affect all stages of deployment.

This risk is described and assessed in Table 20, and mitigation actions proposed in Table 21.

| Risk Event |
|---|
| SWIM is not implemented in its correct form nor sufficiently early |
| **Cause** |
| • Institutional requirements are not agreed in time by all ATM partners<br>• Data networks are not available to support information sharing amongst all partners<br>• Ground and airborne systems are not deployed so as to complete the SWIM Network<br>• User applications are not developed for all types of users |
| **Outcome** |
| • SWIM is unable to support CDM between all the ATM partners thus preventing the capacity and operational efficiency improvements that can be derived from the NOP and trajectory management<br>• Aeronautical information with extended scope is not available to ground and airborne systems<br>• The whole basis of the SESAR Concept of Operations and business case would be jeopardised |
| **Probability** |
| Very High – Based on work performed during the Definition Phase |
| **Impact** |
| Very High – Failure to realise the ATM Target Concept |

Table 20 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Ensure political action is taken immediately to start work on the institutional requirements for SWIM, including standardisation, and that agreements are reached and implementations are started without delay | SESAR JU, EC | End 2008 |
| Ensure that action is directed with urgency at developing the SWIM Network on the basis of existing networks and then developments are carried out to achieve the required service quality appropriate even for the most demanding applications | SESAR JU | End 2009 |
| Ensure that where R&D for SWIM is needed, it is started early and completed as soon as possible | SESAR JU | End 2009 |
| Ensure that all ATM partners agree to share and use the SWIM Network so as to achieve overall system efficiency and early benefits | ATM Stakeholders, SESAR JU, | End 2009 |

Table 21 Mitigation Actions

### 5.2.3 Institutional and Management Processes

The sections below describe the main risks relating to the institutional and management processes covering delivery of the overall Master Plan where occurrence of the risk events identified will likely have a significant impact on the SESAR programme.

#### 5.2.3.1 Regulatory Framework is Unable to Support the Implementation of the Target Concept

The timescales for introduction of change into service (SESAR deployment) will depend on securing regulatory agreement. However, there is a limit to the rate of change that can be brought about in legislation and regulation, even considering various current initiatives to define the future regulatory model.

Starting any regulatory change process cannot take place without clarification of purpose (e.g. with respect to technology, including roles and responsibilities, or whether regulatory change will realize a net benefit) and the technical and procedural changes proposed by SESAR being tested against the current regulatory landscape.

This risk is described and assessed in Table 22, and mitigation actions proposed in Table 23.

| Risk Event |
|---|
| Regulatory Framework, especially regarding safety, is unable to keep pace with and enable the changes needed to implement the Target Concept |
| **Cause** |
| • Lack of sufficient resources with the correct skills and knowledge (even with a Regulatory Framework established, as proposed in D6)<br>• Lack of information to identify the changes required (credible requests) to the Regulatory Framework in order that both changes to the rules can be made, and the regulatory authorities responsible for rule making and oversight can be sized accordingly to respond in a timely manner |
| **Outcome** |
| • Delay to the implementation of the Target Concept<br>• Potential for regulatory fragmentation leading to increased costs for providing assurance<br>• Compromise to the delivery of enhanced performance due to the reliance of “workarounds” to secure regulatory approval |
| **Probability** |
| Medium – Based on regulators being aware change may be required, but not yet having clear indication of what change may be required |
| **Impact** |
| High – Potential serious delays to implementation of the Target Concept |

Table 22 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Early involvement of the regulator to assist in the rule making and the appropriate shaping of the safety regulatory authority | SESAR JU, SSR-CF and EASA | 2008 onwards |
| Early involvement of the regulator to assist in the rule making and the appropriate shaping of the regulatory authorities other than safety (e.g. Airspace, Economic, Environment) | SESAR JU, RICBAN | 2008 onwards |
| Identify and progress required EC regulation, ensuring that proper consideration is given as early as possible to the international standards that may be required to underpin this | SESAR JU | 2008 onwards |

Table 23 Mitigation Actions

#### 5.2.3.2 Performance Based Approach Not Implemented

Delivering an ATM System using the SESAR Performance Based Approach is a stated objective of the SESAR Consortium members and therefore a fundamental element of the Master Plan. The Performance Framework will be managed by the SESAR Performance Partnership that does not exist today. It is likely that it will have a matrix based organisational structure with little direct authority at organisational or national level. The risk is described and assessed in Table 24, and mitigation actions proposed in Table 25.

| Risk Event |
|---|
| Failure to implement the SESAR Performance Based Approach |
| **Cause** |
| • No appropriate process to implement the SESAR Performance Framework<br>• Stakeholders do not commit to ATM Performance Partnership<br>• No appropriate enforcement mechanisms to support/accelerate implementation<br>• Lack of convergence to a common approach by organisations who have notably their own local performance approaches<br>• Failure to reach appropriate levels of common definition that enable Service Level Agreements to be established and become standard operating practice |
| **Outcome** |
| • Heterogeneous targets, objectives, monitoring and reporting across the ATM System with, additionally, an ad hoc selection and decision process for ATM System improvements<br>• At the highest level, the citizens of the EU will have constrained choice and increased delays<br>• At EU level, European competitiveness and GDP will be affected |
| **Probability** |
| High – Performance Partnership does not exist today and its potential structure is still unclear |
| **Impact** |
| High – Without the performance based approach, the ATM System envisaged for 2020 with the associated performance targets and objectives for the 11 ICAO/SESAR Key Performance Areas may not be achieved |

Table 24 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Establish the SESAR Performance Framework including the monitoring and achievement of performance targets | EC/ EUROCONTROL/ All Stakeholders | End 2008 |
| Ensure appropriate enforcement mechanisms are available to ensure transition and implementation of the Performance Based approach | EC | End 2008 |
| Ensure that all future work is carried out in a performance based manner | All Stakeholders | End 2008 |

Table 25 Mitigation Actions

### 5.2.3.3 Failure to manage Human Resources, Human Performance, Social Factors and Change Management

This risk addresses the failure to manage Human Resources, Human Performance, Social Factors and Change Management issues in the development and implementation of the ATM Target Concept. It is described and assessed in Table 26, and mitigation actions proposed in Table 27.

| Risk Event |
|---|
| Failure to manage Human Performance, Human Resources, Social Factors and Change Management issues in the development and implementation of the ATM Target Concept |
| **Cause** |
| • Human Performance not integrated in concepts and development, including applying minimal standards and unrealistic assumptions (especially human workload and automation) and an appropriate Human Performance regulatory and certification framework<br>• Lack of verified and competent Human Resources to support operations in increasing traffic levels, training requirements, and user involvement in design and validation processes<br>• Absence of appropriate Social and Change Management processes and Social Dialogue structures at European, national and local levels |
| **Outcome** |
| • The human has been repeatedly identified as essential to the ATM System and without addressing these risks the future European ATM System will not achieve its objectives |
| **Probability** |
| High – Based on the current status with respect to the required actions |
| **Impact** |
| High – Due to the pan-European nature of the issues and significant dependencies |

Table 26 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Establish a Human Performance Steering Function to enable proactive identification of training requirements, Social and Change management risks | SESAR JU/ATM stakeholders | Ongoing process |
| Issue regular recommendations and activity plans for Human Performance and Social Factors management in the area of R&D, regulation, standards, and management at industry level | SESAR JU/ EUROCONTROL, ATM stakeholders | Ongoing process |
| Ensure that systematic examination of Human Performance and competence requirements impacts are part of all SESAR oriented R&D based on recognised methods and standards recommended by the Human Performance Steering Function (HPSF) | SESAR JU/ EUROCONTROL, ATM stakeholders | Ongoing process |
| Based on above mentioned activity plans, regularly examine staffing implications of all deployment activities for all groups of operational aviation staff and publish results and related recommendations | ATM stakeholders | Ongoing process |
| Start adaptation and development of training and competence related regulations and standards 5 to 7 years in advance of deployment date | Affected international regulatory and working bodies (e.g. EC, EASA, EUROCONTROL) | End 2008 |
| Set up stable and reliable Social Dialogue structures and apply best practices at European, national and local levels | EC, ATM Stakeholders | End 2008 |
| Set up a progress monitoring and risk management process for Social Factors and Change Management risks | SESAR JU, ATM Stakeholders, EC | End 2008 |
| Further develop advisory material for sustainable social and change management | SESAR JU, ATM Stakeholders, EC | End 2008 |
| Engage all affected Stakeholders in the SESAR JU Working Groups and make full use of the EU Social Dialogue Committee for Civil Aviation | SESAR JU, ATM Stakeholders, EC | End 2008 |

Table 27 Mitigation Actions

#### 5.2.3.4 No Agreement on Future Defragmentation of European Airspace

Although not required to achieve the Target Concept operationally, the issue of defragmentation is critical particularly with regard to meeting cost effectiveness targets. The risk affects all ATM users (more especially the airspace users) and is described and assessed in Table 28, and mitigation actions proposed in Table 29.

| Risk Event |
|---|
| Defragmentation (FABs) of European airspace will be not achieved in time to deliver cost gains |
| **Cause** |
| • Overall high level political activities not coming to agreement<br>• Infrastructure changes to enable the creation of FABs are not carried out<br>• Social changes necessary to work the FABs cannot be agreed |
| **Outcome** |
| • Delayed delivery of performance benefits that are conditional upon FAB implementation.<br>• Serious negative effect on performance as the trajectory management concept requires larger blocks of boundary-less airspace. |
| **Probability** |
| Very High – Decisions required at political level involving many complex arguments |
| **Impact** |
| High – Target Concept may be implemented, but cost efficiency targets not met |

Table 28 Risk Assessment

| Mitigation | By Who? | By When? |
|---|---|---|
| Ensure political action at the highest EU level to ensure that the FABs are created and that States appreciate the costs of non-compliance | EU and DGCAs | Ongoing |
| Rationalise European ATM ground infrastructure (e.g. fixed route structure, ground-based navigation aids, ATC facilities, information systems), architecture and technology to be in line with the technological opportunities provided by the ATM Target Concept and in order to fully meet the D2 performance requirements | ANS Providers/ Airports | Progressively |
| As an insurance, early attention to the creation of a SWIM network, with its enhanced data transfer capability, would give the possibility of virtual FABs which, though second best, would serve to deliver some of the benefits forecast for physical FABs (without encountering the social issues of transfer of Staff to distant ATCCs) | ANS Providers | 2012 |

Table 29 Mitigation Actions

## 5.3 Key requirements for the SESAR future

The objective of the Master Plan is to meet the performance targets and to deliver the expected benefits to the ATM stakeholders. The following **seven key requirements have been identified as critical for the successful implementation of the Master Plan:**

1. Establishing a **single European Legislative Framework:** The rationalisation and alignment of European and national regulations is essential for the full implementation of the Single European Sky. However, regulation should only be used where necessary in accordance with "better regulation" principles to reach agreements and to support enforcement of commitments across the diversity of Member States and stakeholder interests;

2. A **performance-driven approach:** The SESAR performance framework builds on ICAO guidance material and existing processes to develop a European-wide system for setting, agreeing, and maintaining performance targets. This needs to be established within the regulatory framework as anticipated by the European Commission to reach the required improvements in safety, efficiency, capacity, environmental sustainability and cost-effectiveness. The whole approach needs to be supported by a comprehensive monitoring and reporting system;

3. Clear **ownership and endorsement of the Master Plan** at all levels, political, regulatory, and industry. In consequence, this will require transparency and alignment of the operating and investment plans of all stakeholders, in particular, NSAs, ANS Providers, airspace users (including the military), airports and third party suppliers (supply industry, aircraft manufacturers, etc.);

4. Definition of **clear governance and leadership structure for the deployment** activities covering all phases is vital.

   This coordination should be realised:
   (a) through the implementation of the deployment programmes, which need to be agreed,
   (b) through strengthening stakeholder engagement and influence in appropriate forums, e.g. a future ATM Performance Partnership as part of the business framework and specifically for Implementation Package 1
   (c) through the re-enforcement of a renewed ECIP/LCIP process to cover the SES monitoring requirements;

5. The establishment of a **single system design function:** Having established an European ATM Enterprise Architecture to facilitate the ATM performance partnership, a single system design function needs to be formed as referenced in SESAR Deliverable D1 for the design of the technical architecture of the future ATM System;

6. To ensure **interoperability of SESAR results** at regional and global level, it is necessary to link the system design activities with the existing standardisation processes (EUROCAE, RTCA, etc.) including the military and the respective regulatory structures (SES, ICAO, etc.);

7. Industry must be able to **balance cost and benefits.** The long lead times in some areas of the Master Plan may need measures to guarantee proper funding, where necessary through incentives, to keep to the schedule for investing in the deployment of the SESAR target solutions and decommissioning legacy systems.

# 6 List of References


1 Milestone Objective Plan D5: ATM Master Plan – MGT-0506-005-03-00

2 Milestone Deliverable D1: Air Transport Framework – The Current Situation - DLM-0602-001-03-00

3 Milestone Deliverable D2: Air Transport Framework – The Performance Target - DLM-0607-001-02-00

4 Milestone Deliverable D3: ATM Target Concept - DLM-0612-001-02-00

5 Milestone Deliverable D4: ATM – Deployment Sequence - DLM-0706-001-02-00

6 Task Deliverable: 3.4.1/D5 – ATM Master Plan Consolidation

7 Task Deliverable: 3.4.2/D5 – Deployment Planning

8 Task Deliverable: 3.4.3/D5 – R&T/D Programme Planning

9 Task Deliverable: 3.4.4/D5 – Benefit Planning

10 Task Deliverable: 3.4.5/D5 – Financial and Investment Planning

11 Task Deliverable: 3.4.6/D5 – Regulatory and Legislative Planning

12 Task Deliverable: 3.4.7/D5 – Risk Management

13 SESAR Definition Phase – Performance Objectives and Targets Report – RPT-0708-001-01-02

14 ICAO Global Performance Manual (GPM)

15 EUROCONTROL E-OCVM

16 Task Deliverable: 1.2.2/D4 – Definition of new mechanisms for timely and harmonised decision making

17 Task Deliverable: 2.2.2/D3 – Definition of future ATM Concept of operations, highlighting airspace design aspects.

18 Milestone Deliverable D6: Work Programme 2008-2013 – DLM-0710-001-02-00

19 European Airspace Strategy; 2015 Concept and Strategy for the ECAC area and key enablers (edition 2.0)

# 7 List of Abbreviations and Terminology

## 7.1 Abbreviations

| Abbreviation | Explanation |
|---|---|
| 2D, 3D, 4D | 2 Dimensional, 3 Dimensional, 4 Dimensional |
| A-CDM | Airport Collaborative Decision Making |
| AAMS | Advanced Airspace Management System |
| ABAS | Aircraft Based Augmentation System |
| ACARS | Aircraft Communications Addressing and Reporting System |
| ACAS | Airborne Collision Avoidance System |
| ACC | Area Control Centre |
| ACDA | Advanced Continuous Descent Approach |
| ACCD | Advanced Continuous Climb Departure |
| ADD | Airborne Derived Data |
| ADEXP | Adaptation to new aircraft operator-ANS Provider flight plan data exchanges |
| ADS-B/-C | Automatic Dependent Surveillance - Broadcast/-Contract |
| AFUA | Advanced Flexible Use of Airspace concepts |
| AGDL | Air-Ground Datalink |
| AGDLGMS | Air-Ground Datalink Ground Management System |
| AIR | AIRborne |
| AI/AIM/AIMS/AIS/AIP | Aeronautical Information/Management/Management System/Publication/Service |
| AICM | Aeronautical Information Conceptual Model |
| AIXM | Aeronautical Information Exchange Model |
| AMAN | Arrival Management/Arrival Manager |
| AMC | Airspace Management Cell |
| AMHS | Aeronautical Message Handling System |
| ANS/-P | Air Navigation Service/-Provider |
| AOC | Airline Operational Control |
| APP | APProach |
| APV | Approach with Vertical guidance |
| ASAS | Airborne Separation Assistance System |
| ASAS-SSEP | ASAS Self Separation |
| ASEP-C&P/WV/ITP | ASAS Separation Crossing&Passing/Wake Vortex/In Trail Procedure |
| ASM | Airspace Management |
| ASPA | Airborne SPAcing |
| A-SMGCS | Advanced Surface Movement Guidance and Control System |
| ATC | Air Traffic Control |
| ATCO | Air Traffic Control Officer |
| ATFCM | Air Traffic Flow and Capacity Management |
| ATFM | Air Traffic Flow Management |
| ATM | Air Traffic Management |
| ATN | Aeronautical Telecommunication Network |

| Abbreviation | Explanation |
|---|---|
| ATS | Air Traffic Service |
| ATSA -/ITP/VSA | Airborne Traffic Separation Assurance -/ITP - In Trail Procedure in Oceanic airspace/VSA - Enhanced visual separation on approach |
| ATSAW | Airborne Traffic Situational Awareness |
| ATSEP | Air Traffic Safety Electronics Personnel |
| BA | Business Aviation |
| Bn | Billion |
| BTV | Brake To Vacate |
| C&P | Crossing & Passing |
| CAPEX | Capital Expenditure |
| CAT | Category |
| CBA | Cost Benefit Analysis |
| CCD | Continuous Climb Departure |
| CDA | Continuous Descent Approach |
| CDM | Collaborative Decision Making |
| CEM | Collaborative Environment Management |
| CEN / CENELEC | European Committee for Electrotechnical Standardisation |
| CFMU | Central Flow Management Unit |
| CHAIN | Controlled and Harmonized Aeronautical Information Network |
| CNS/ATM | Communication Navigation Surveillance/Air Traffic Management |
| ConOps | SESAR Concept of Operations |
| CR | Common Requirements |
| CPDLC | Controller Pilot Datalink Communication |
| CS | Community Specifications |
| CTA | Controlled Time of Arrival |
| CTO | Controlled Time of Over- fly |
| D-ATIS | Digital Aeronautical Terminal Information Service |
| DCB | Demand and Capacity Balancing |
| DCL | Departure Clearance |
| DLM | Milestone Deliverable |
| DLT | Task Deliverable |
| DMA | Dynamic Mobile Area |
| DMAN | Departure Manager |
| DME | Distance Measuring Equipment |
| EAD | European AIS Database |
| EAEA | European ATM Enterprise Architecture |
| EATM | European Air Traffic Management |
| EC | European Commission |
| ECAC | European Civil Aviation Conference |
| ECIP | European Convergence and Implementation Plan |
| EGCSA | Enhanced Ground Controller Situational Awareness |
| ENR | En-Route |
| EMS | Environment Management System |
| ESO | European Standards Organisation |
| ETSI | European Telecommunications Standards Institute |
| EU | European Union |
| EUROAT | EUROCONTROL harmonized Rules for Operational Air Traffic under Instrument Flight Rules (IFR) inside controlled Airspace in the ECAC Area |
| EUROCAE | European Organisation for Civil Aviation Equipment |

| Abbreviation | Explanation |
|---|---|
| EV | Enhanced Vision |
| EVS | Enhanced Visual System |
| FAB | Functional Airspace Blocks |
| FDP/S | Flight Data Processing/System |
| FMAS | Flexible Military Airspace Structures |
| FMS | Flight Management System |
| FOC | Full Operating Capability |
| FOC | Flight Operations Centre |
| FP/FPL | Flight Plan |
| FUA | Flexible Use of Airspace |
| GA | General Aviation |
| GAT | General Air Traffic |
| GBAS | Ground Based Augmentation System |
| GDP | Gross Domestic Product |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HALS | Human Assurance Levels |
| HF | Human Factors / High Frequency |
| HMI | Human Machine Interface |
| HP | Human Performance |
| HPSF | Human Performance Steering Function |
| HRA | Human Reliability Assessment |
| HUD | Head Up Display |
| IAF | Initial Approach Fix |
| IATA | International Air Transport Association |
| ICAO | International Civil Aviation Organisation |
| ICB | Industry Consultation Board |
| ID | Identity |
| IFR | Instrumental Flight Rules |
| IMC | Instrument Meteorological Conditions |
| iMS | Integrated Management System |
| IOC | Initial Operating Capability |
| IOP | Interoperability |
| IP | Implementation Package, Internet Protocol |
| KPA | Key Performance Area |
| KPI | Key Performance Indicator |
| ILS | Instrument Landing System |
| ITP | In Trail Procedure |
| LCIP | Local Convergence and Implementation Plan |
| LED | Light Emitting Diode |
| LoC | Lines of Change |
| LPV | Localizer Procedure with Vertical guidance |
| M | Million |
| MET | Meteorological information Service |
| MIL | Military |
| MLAT | Multi-LATeration |
| MONA | Monitoring Aids |
| MOP | Milestone Objective Plan |
| MOPS | Minimum Operational Performance Specifications |

| Abbreviation | Explanation |
|---|---|
| MSPSR | Multi-Static Primary Surveillance Radar |
| MTCD | Medium Term Conflict Detection |
| MVPA | Military Variable Profile Area |
| NATO ACCS | North Atlantic Treaty Organisation Air Command and Control System |
| NDBX | Nav Data Base X |
| NIMS | Network Information Management System |
| NOP/NOPLA | Network Operation Plan/ Network Operation Planner |
| NOTAM | Notice to Airmen |
| OAT/-TS | Operational Air Traffic/-Transit Services |
| OI/OIS | Operational Improvement/Operational Improvement Step |
| PRC | Performance Review Commission |
| PRNAV | Precision aRea NAVigation |
| PT | Predicted Trajectory |
| PTC | Precision Trajectory Clearances |
| QoS | Quality of Service |
| R&D | Research and Development |
| RA | Resolution Advisory |
| RAMS | Regional Airspace Management System |
| RBT | Reference Business/Mission Trajectory |
| RET | Rapid Exit Taxiways |
| RNAV | Area Navigation |
| RNP | Required Navigation Performance |
| RNP AR | Require Navigation Performance Approval Required |
| ROT | Runway Occupancy Time |
| RTA | Required Time of Arrival |
| RTCS | Recruitment, Training, Competence and Staffing |
| RVSM/-MASPS | Reduced Vertical Separation Minima/-MASPS |
| RWY | Runway |
| SecMS | Security Management System |
| S&M | Sequencing & Merging |
| SATCOM | Satellite Communications |
| SBAS | Space/Satellite Based Augmentation System |
| SBT | Shared Business/Mission Trajectory |
| SFCM | Social Factor and Change Management |
| SES | Single European Sky |
| SESAR | Single European Sky ATM Research Programme |
| SESAR JU | SESAR Join Undertaking |
| SMAN | Surface Manager |
| SMGCS | Surface Movement Guidance and Control System |
| SMP | Safety Management Plan |
| SMS | Safety Management System |
| SOA | Service Oriented Approach |
| SSC | Single Sky Committee |
| SSEP | Self Separation |
| SSR-CF | SESAR Safety Regulatory - Coordination Function |
| STAR | Safety Target Achievement Roadmap |
| STCA | Short Term Conflict Alert |
| SV/SVS | Synthetic Vision/ SV System |
| SWIM | System Wide Information Management |
| TCAS | Traffic Collision Avoidance System |

| Abbreviation | Explanation |
|---|---|
| TCM | Trajectory Conformance Monitoring |
| TMA | Terminal Manoeuvre Area |
| TMR | Trajectory Management Requirements |
| TOC | Top of Climb |
| TOD | Top of Descent |
| TSA | Temporary Segregated Area / Traffic Situational Awareness |
| TTA | Target Time of Arrival |
| TWR | Aerodrome Control Tower |
| UDPP | User Driven Prioritisation Process |
| VGA | Variable Geometry Airspace |
| VHF | Very High Frequency |
| VMC | Visual Meteorological Conditions |
| VNAV | Vertical Navigation |
| VoIP | Voice over IP |
| WAM | Wide Area Multi-lateration |
| WV | Wake Vortex |
| XML | eXtendable Mark-up Language |
| XNOTAM | Digital NOTAM |

## 7.2 Terminology

### Business services

These are the items being offered by the supplier, some of which will be bought by a consumer. Such business transactions will be based on contracts or service level agreements. As an example, airports and ANS Providers offer services that an airspace user may need in order to fly the Business/Mission trajectory. Separation provision could be such a service, which the airspace user may elect to use in some parts of the airspace or is obliged to use in others. Queue management service could be another example. Provision of the given service to the required level of performance and its price would be the subject of a contract or service level agreement.

### Information Technology services

These are services that correspond to ATM business activities or recognizable business functions, which can be accessed according to the service policies that have been established for the business services relationship. In addition to the IT services that are directly supporting the business services, technical services can be defined that can be re-used across different IT aligned business services providing generic technical functions (data transformation, logging, identification management, etc).

# 8 List of Figures and Tables

# 9 Annexes

## 9.1 Background

### D1-D4 highlights – leading to the D5 SESAR Master Plan

This section is reminding the reader of the main findings from the previous SESAR Definition Phase Milestone Deliverables D1 – D4.

## Air Transport – a continuously growing demand facing challenges

Air Transport is a vital element of people's lives around the world. It stimulates national economies, global trade and tourism. It brings people together, face to face, as friends & families and facilitates business opportunities. It responds to these human needs as no other manner of communication can. This is the main reason, together with the expected increase of the worldwide Gross Domestic Product (GDP), for a sustainable growth demand in Air Transport. Furthermore the military aviation (all of which is included in the SESAR definition of Air Transport) enables States to support their defence and security policies.

In 2004, the direct stakeholders of the Air Transport industry accounted for about €220Bn of added value and 4 Million jobs in the European economy, either directly or indirectly – i.e., approximately 1.5% of European Gross Domestic Product (GDP).

### European Aviation Operations

In 2007, on a peak day, ATM controls ~30,000 Commercial flights operated by ~5,000 aircraft. Services are also provided to ~200,000 General Aviation (GA) flights operated yearly by ~50,000 aircraft, plus numerous Military flights. In addition, new types of air vehicles are emerging such as Very Light Jets and Unmanned Aerial Vehicles. As a result of the growing GDP, the annual European traffic demand - if unconstrained - is forecast to reach up to 18 Million IFR (Instrument Flight Rules) flights by 2020. "Hub & spoke" and "point-to-point" concepts of operations are performed which together create a complex air transport network containing many rotations of aircraft to maximise their cost effectiveness to the business. Military Aviation has a vital role to play in the security in Europe. States may act alone or within international organisations (e.g. NATO) and may require military aircraft to take precedence over civil aviation in some tightly defined circumstances. It is a fundamental responsibility that each State is able to train and operate its military forces. The volume of military traffic will remain stable but new generations of aircraft with increased capabilities will need access to larger blocks of airspace.

### Present Performance

Over the past decade ANS Providers have coped with significant traffic growth in an acceptably safe and expeditious manner. However, the following characterises today's situation in Europe:

- When considering the value chain of the principal stakeholders within the industry the commercial airspace users are the most exposed link, since they are "pulled" between the need to compete for customers in a globally competitive business sector, whilst being faced with high fixed costs;
  - Their exposed position means they are the first to suffer the financial consequences of sudden falls in demand;
  - This situation is a major risk to achieving the long-term economic sustainability of the whole chain.
- ATM is predominantly a tactical air traffic control process supported by a number of traffic management planning functions;
- At present, capacity at airports and TMAs (i.e., their infrastructure, environmental and political constraints) is primarily the limiting factor of overall ATM System capacity;
  - In the future, Airport infrastructure developments will have to keep pace with the capacity improvements in airspace.
- Delays in the Enroute sector are at low levels, however, delays are concentrated in high air traffic density areas;
- The ATM System is historically fragmented leading to substantial inefficiencies;
- National infrastructures have low levels of interoperability, limited sharing of data and little co-operative planning in the way their assets are managed;
- The full cost recovery regime does not incentivise organisations to seek the most cost-efficient solutions to implement changes when making strategic investments;
- Much performance data is captured, but not used coherently to manage the business in a systematic, integrated and "closed-loop" way;
- Today's ATM flow-management is not adequately geared to maintaining the schedules of commercial airspace users and supporting them in handling schedule changes;
- The adaptability of the current ATM System to the traffic demand is rather limited due to the fragmented infrastructure;
- **ATM network inefficiencies** are estimated to be ~ €2Bn for cost effectiveness (€1.4Bn for ATM/CNS en-route fragmentation (worst case) & ~€0.6Bn for associated low productivity); ~€1.4Bn associated with flight inefficiencies; ~€1Bn associated with ground ATM delays.

## SESAR - Key for Success

In response to the ATM challenge, the European Commission (EC) launched the SESAR programme, with the objectives, as expressed by Vice-President Jacques Barrot, to achieve a future European ATM System for 2020 and beyond, which can, relative to today's performance:

- **Enable** a 3-fold increase in capacity which will also reduce delays, both on the ground and in the air;
- **Improve** the safety performance by a factor of 10;
- **Enable** a 10% reduction in the effects flights have on the environment;
- **Provide** ATM services at a cost to the airspace users, which is at least 50% less.

## Vision

The proposed SESAR Vision is to achieve a performance based European ATM System, built in partnership, to best support the ever increasing societal and States', including military, expectations for air transport with respect to the growing mobility of both citizens and goods and all other aviation activities, in a safe, secure, environmentally sustainable and cost-effective manner.

Central to achieving this Vision, is the concept of placing the best overall outcome of individual flights at the heart of the ATM network.

The SESAR Vision is dependent upon three distinct ATM frameworks, to which all stakeholders have to commit and operate:

- The "Performance Framework";
- The "Business Management Framework";
- The "Institutional and Regulatory Framework".

## The Performance Framework

An ATM performance based approach is considered essential to drive management decisions towards achieving the Vision.

This "Performance Framework" provides a common basis to ensure the effectiveness of the ATM System and links the other two ATM frameworks - "Business Management Framework" & "Institutional and Regulatory Framework" - together which are balancing general public and industry interests in a "dynamic working relationship", that addresses how the safety, security, environmental, design and financial aspects are managed and regulated.

The SESAR Consortium addressed the definition of the performance framework by defining 11 Key Performance Areas. It has also given a particular focus to the 2020 milestone by setting initial targets. These will be continuously refined when needed and potentially expanded within the lifetime of the Master Plan.

Four KPAs, directly linked to EC objectives and the achievement of the proposed SESAR Vision are described below.

### Capacity

The deployment of the ATM Target Concept should be progressive, so that only the required capacity is deployed at any time.

The target for Capacity deployment is that the ATM System can accommodate by 2020 a 73% increase in traffic (from 2005 baseline), but with the potential to accommodate the design goal of a threefold increase where required, while meeting the targets for safety and quality of service KPAs (Efficiency, Flexibility, Predictability).

### Safety

The SESAR safety performance objective builds on the ATM2000+ Strategy objective: "To improve safety levels by ensuring that the numbers of ATM induced accidents and serious or risk bearing incidents (includes those with direct and indirect ATM contribution) do not increase and, where possible, decrease".

Considering the anticipated increase in the European annual traffic volume, the implication of the initial safety performance objective is that the overall safety level would gradually have to improve, so as to reach an improvement factor of 3 in order to meet the safety objective in 2020 and a factor 10 for the design goal (based on the assumption that safety needs to improve with the square of traffic volume increase).

### Environment

ATM will deliver its maximum contribution to the environment. As a first step towards the political objective to enable a 10% reduction in the effects flights have on the environment it is necessary to:

- Achieve the implicit emission improvements through the reduction of gate-to-gate excess fuel consumption addressed in the KPA Efficiency. However no specific separate target could be defined at this stage for the ATM contribution to atmospheric emission reductions.
- Minimise noise emissions and their impacts for each flight to the greatest extent possible.

- Minimise other adverse atmospheric effects to the greatest extent possible. Suitable indicators are yet to be developed.
- Take measures so that all proposed environmentally related ATM constraints are subject to a transparent assessment with an environment and socio-economic scope; and, following this assessment the best alternative solutions from a European Sustainability perspective are seen to be adopted.

Local environmental rules affecting ATM are to be 100% respected (e.g. aircraft type restrictions, night movement bans, noise routes and noise quotas, etc.). Exceptions are only allowed for safety or security reasons.

### Cost-Effectiveness

The working assumption for the Cost Effectiveness target is to halve the total direct European gate-to-gate ATM costs from €800/flight (EUROCONTROL Performance Review Report 2005) to €400/flight in 2020 through progressive reduction. Notwithstanding this 2020 target, continuing cost improvement should be sought after 2020.

## The ATM Business Management Framework

Its objective is to ensure that the new ATM Target Concept will be fully implemented and operated in a consistently organised manner throughout all phases of the European ATM System lifecycle, including ATM strategic planning starting with the Master Plan.
The Business Management framework should be established by an ATM Performance Partnership whereby the Civil Airspace Users (both Commercial and Non-Commercial), Military, ANS Providers, Airports, Supply Industry (for their design part), EUROCONTROL (for their pan-European functions) and Social Partners to:

- Reconcile the different partners' business and/or mission objectives;
- Identify those aspects of their visions which are common in terms of creating and managing the future ATM System;
- Define how the partners should interact to create and manage the future System.

In particular joint decision-making and coordinated business planning must be the basis of the Master Plan. **The introduction of this framework represents a paradigm shift for each stakeholder** from the present fragmented decision making process to the execution of common ATM strategic planning.
Functional Airspace Block (FAB) initiatives are strongly supported and seen as one of the main vehicles to improve ATM performance, reducing the impact of fragmentation on the cost of air traffic service provision. These will initially develop through regional arrangements between States and ANS Providers and lead to further ANS Provider cooperation, alliances or mergers, including the appropriate regulatory structures.

## The ATM Institutional and Regulatory Framework

Its objective is to ensure societal expectations are met and to enable the development, operation and growth of a sustainable European air transport system, through the Business Framework.
The framework needs to have a simple and well-structured set of regulations and regulatory actions allocated at global, European or national level, whilst continuing to rely on EC and Member States for enforcement. It will respond to States' requirements and work closely with industry to ensure rules are fair, proportionate and to safeguard a level playing field.
The SESAR Joint Undertaking (JU), as the first European ATM Public-Private Partnership, is seen as an important move forward and an initial step to manage the development of SESAR. It is the structure that will execute and maintain the Master Plan during the Development Phase managing the R&D programme of technical activities, and monitoring its deployment.

The ATM Institutional and Regulatory Framework has to be flexible so it easily adapts to business and societal changes. Although outside the scope of the SESAR project, the modernisation of this framework is considered by the industry to be urgent.

## New ATM Target Concept – The Goal

The ATM Target Concept follows a service-oriented approach based on an ATM stakeholder performance partnership. The ATM Target Concept represents a paradigm shift from an airspace route-based environment to an aircraft trajectory-based environment. Underpinning the entire ATM system is **System Wide Information Management (SWIM)**, including aircraft as well as all ground facilities. SWIM will be the information management backbone for all **Collaborative Decision-Making** processes; end-user applications will thus be able to exploit the power of shared information.
The primary objective of the ATM Target Concept is to obtain the

"best overall outcome" for a flight – this characteristic of the ATM Target Concept is referred to as the "Business Trajectory".

The "Business Trajectory" (or "Mission Trajectory" for Military and GA) is the representation of an airspace user's intention with respect to a given flight, guaranteeing the best outcome for this flight (as seen from the airspace user's perspective), respecting momentary and permanent constraints. At the airspace user's discretion this outcome may, with respect to the minimum time/fuel/emission for the flight, be the minimum cost, or any other characteristic of the trajectory.

The ATM Target Concept is not about one size/one solution fits all; it offers different concept features which can be tailored to the specific local needs to meet the local performance objectives and their harmonised evolution in the life time of SESAR. It addresses the needs of all Airspace Users operations.

**The SESAR Consortium has achieved agreement on the ATM Target Concept and its intermediate 2013 and 2020 steps ("2020 ATM System").** Further validation and development of 2020+ ATM Target Concept elements will take place as part of the SESAR Development Phase.

The business/mission trajectory is based on a **4-D flight trajectory** supplemented with additional information, describing the business attributes of the flight, under the overall coordination of **network wide traffic management**.

Fundamental to the entire **ATM Target Concept is a 'net-centric' operation** based on

- A powerful, information sharing, SWIM network;
- New air-air, ground-ground and air-ground data communications systems;
- New Separation Modes involving trajectory clearances and airborne modes;
- An increased reliance of airborne and ground based automated support tools;
- A Collaborative Decision Making based on trajectory management mechanism.

Airports will become an integral part of the ATM system as part of the Enroute-to-Enroute perspective of trajectory management. Increased throughput and reduced environmental impact is envisaged.

The ATM Target Concept **remains 'human-centric'** i.e. that humans (with appropriate skills and competences, duly authorised) will constitute the core of the future European ATM System. However, to accommodate the expected traffic increase and complexity, an advanced level of automation support for the humans will be required. Collaborative Planning will be continuously reflected in the Network Operations Plan (NOP).

The **ATM System architecture** is defined to support the ATM Target Concept, servicing aircraft with the flexibility and adaptability to adjust to changing traffic flows, performance requirements and different local conditions while capitalising on the current SESAR ATM Target Concept developments.

**Technology enablers** meeting the identified operational and architecture requirements in providing and distributing the information in time and to the right location with the required availability, continuity and integrity have been identified:

- **The communication systems** will increasingly use digital/data technology and protocols leading to a full integration of terrestrial and satellite networks towards SWIM, connecting all ATM sub-systems;
- **The primary navigation system** will be satellite based, with a fall back solution to mitigate against a potential blackout of satellite navigation services;
- **New** ADS-B based **surveillance systems** will increasingly provide improved 4D-position information (accurate position and time).

## Performance Analysis of the ATM Target Concept

### The main operational benefits

It is predicted that in 2020, the ATM system will be able accommodate 16 Million flights per year with an average ATFM delay of 0.5 minutes per flight and greater fuel efficiency (corresponding to a fuel saving of approximately 3% compared to the 2007 baseline). Capacity needed to meet the traffic demand will be provided with the required level of safety and security while minimising the environmental impact. The future ATM bottlenecks are expected to be located at some congested airports and/or TMA airspaces, making the achievement of the respective targets more challenging in those areas. The achievement of the **capacity targets** will be supported by:

- 4D Trajectory Management;
- New separation modes;
- Wide availability of controller support tools;
- Collaborative planning and balancing of traffic demand and capacity;
- Reduction in trajectory uncertainty;
- Improved airport processes.

The efficiency gain provides a significant delay reduction, decreasing from 45 Million minutes in 2008 to 16Million minutes in 2020. This will represent about €9Bn indirect cost savings over the period 2008-2020.

The deviation from optimum flight profile will be reduced from 12.3% (2008) to 8.7% (2020). This efficiency gain will allow Time Efficiency savings (not quantified) and significant Fuel Efficiency savings that will be close to 17Million tonnes of fuel over the 2008-2020 period. This will represent about €8Bn indirect cost savings over the period 2008-2020.

This Fuel Efficiency savings reduces gaseous emission and thus will constitute the major contributor to the Environment Sustainability KPA.

It is predicted that the target for Service Disruption in Case of Low Visibility will be reached by reducing the gap between Low Visibility and nominal condition from 50% (2008) to 20% (2020). This will represent about €2Bn indirect cost saving over the period 2008-2020.

Significant improvements in respect of (a) Predictability and (b) a higher Flexibility in the use of airspace and (c) reactions to short-notice changes allowing a better robustness and resilience to service disruptions.
All the above-mentioned operational benefits generate also Passenger Travel Time savings of approximately €12.5Bn.
**It was assessed that the implementation of the 2020 ATM System will deliver the performances needed to satisfy the safe growth of the European air transport industry and thereby the European economy and reduce the effects aviation has on the environment. Subsequent progressive implementation of the full ATM Target Concept is expected to closer meet all of the Performance Targets.**

**Environment**
Efficiency gains through the stepwise implementation of 2020 ATM System will have a direct reduction effect on the **Environmental** impact of every aerial vehicle movement in European Airspace and at European Airports. The main benefits can be summarised as follows:

- The reduction in fuel burn due to optimisation of flight profile translates directly to an overall reduction of gaseous emissions;
- Initiatives such as Green approaches will, in areas where noise and environment around populated areas is an issue, improve local air quality and duration and intensity of noise exposure;
- At the airport, reduction will be achieved through the expansion of best "practices" (e.g. reduction of taxi time) and integrating the airport collaborative environment management process in the ATM network;
- The enhancements in air traffic management have the potential to reduce the CO2 emission over the 2008 to 2020 period with around 50 Million Tons, contributing to the overall objective of an environmentally sustainable growth.

An Environmental Sustainability culture within ATM Governance needs to be developed to provide a framework to ensure a more sustainable ATM in respect of responsibility/ accountability, performance tracking & response and communications.

**Safety** is a design driver since any capacity increase shall not deteriorate the Safety level. The economic benefits of Safety are associated in the accommodation of more traffic. No direct Safety quantitative assessment has been performed however an initial qualitative assessment indicates that the level of Safety increases at least proportionate with the traffic growth as the majority of the operational improvements in the ATM Target Concept have a positive contribution to safety. Early deployment of specific initiatives like runway incursion, improved performance of the safety nets will have a direct positive effect on safety. Additional safety benefits are foreseen with the introduction of new communication, navigation and surveillance technologies, providing better access to information and enabling the position of every aircraft (including GA) and vehicle to be electronically visible to other users of the system.

A quantitative Safety assessment has to be performed during the next phases of SESAR when development and implementation activities are undertaken to validate the goal to improve the safety performance, which is in direct correlation to the traffic increase.

It is recommended that Safety improvements will be supported by an appropriate Safety Management Framework. In addition, early deployment of specific initiatives on identified Safety issues like runway incursion have been included in the Master Plan.

**ATM Security shall be seamlessly embedded throughout the ATM System and in its constituent ATM Target Concept elements. Security aspects of the ATM Target Concept** have been analysed in respect of self-protection and collaborative security support. In order to show evidence of the expected security benefits, the potential risk contributions need to be identified by continuous appropriate analysis of security issues during the development and deployment of the ATM Target Concept and by developing appropriate security assessment methodologies and procedures.

## Implementation of the ATM Target Concept

The implementation of the ATM Target Concept has been divided into three successive Implementation Packages (IPs)[17]. **The Members of the SESAR Consortium are committed to the implementation steps proposed for the shorter term and recommend the launch of the development and validation activities according to the proposed transition sequence.**
**IP1 from 2008 – up to 2013 –** represents the foundation of the ATM Deployment Sequence on which the following Implementation Packages are built. It can only be achieved if all European ATM stakeholders fully commit to the timely and effective implementation of all activities identified in IP1. It will need to be supported by co-ordinated planning, implementation and business oriented management at European ATM network level with the aim to ensure the best use of European airspace capacity and efficiency resources. The operation of a more integrated European ATM network has the potential to generate savings estimated between €0.7-1.1Bn/year for airspace users and also to meet the other performance requirements. **IP1 will accommodate demand by 2013 if all initiatives are implemented on time and as planned. Any delay or failure to implement IP1 will impact the rest of the ATM Deployment Sequence.**
**IP2 from 2013 – up to 2020,** by timely implementation of all the

[17] It shall be noted that within this D5 document the IPs are further split into ATM Service Levels providing an extra granularity to better match the "rolling" Master Plan update process.

activities needed to achieve the 2020 targets; The Implementation Package 2 will deliver a wider information-sharing environment, which will be the driver for improved efficiency of the ATM network as a whole. IP2 will deliver the implementation of the 2020 ATM System. Its definition has identified all the activities required to achieve it and the associated timeframe. In support, a first analysis of on-going and future R&D activities, which have to be tackled by the SESAR JU has been conducted. **Rigorous performance monitoring must apply** for the development activities in support of IP2 with the appropriate focus on the achievement of the IP2 performance targets.

**IP3 from 2020 – onwards –** targeting the activities necessary for further performance enhancement of the overall ATM system beyond 2020 to fully realise the ATM Target Concept.

## Investments for IP1 & IP2

The total investment for the implementation of the 2020 ATM System amounts to €30Bn considering all stakeholder groups. **It has been concluded that benefits resulting from the implementation justifies the corresponding investment, subject to more complete validation during the SESAR Development Phase.**

Figure 52 illustrates the Stakeholders investment costs assessed for the implementation of IP1 and IP2.

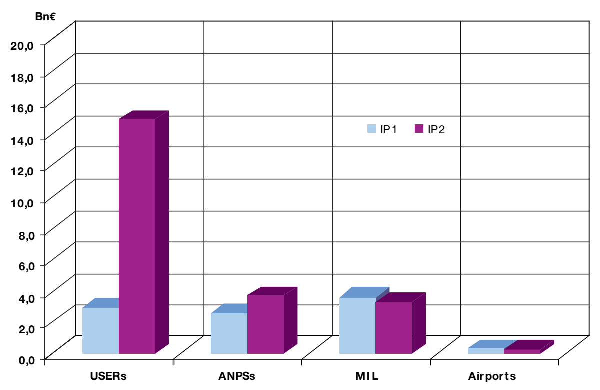


Figure 52: Stakeholder Investment Costs

The cost for the equipage of an average large commercial aircraft to implement IP2 capabilities is estimated to be around €1 Million. However, **non-synchronised adoption of the deployment programme for their part by any stakeholder could reduce benefits considerably and increase the risk of the overall project.** A number of measures are required:

- Local, regional as well as all user group's needs to be carefully addressed by the Master Plan and the SESAR JU, in order to get buy-in;
- Innovative incentive schemes need to be defined that will strongly foster an accelerated investment strategy:
  - o Mandates backed by incentives and disincentives are required for ensuring synchronisation;
  - o Grants and other incentives are particularly required for meeting the pre-financing requirements during the period of 2013 to 2017;
  - o Any grants and other incentives shall normally be used based on service level agreements between service providers and airspace Users and linked to achieving the SESAR Master Plan implementation targets;
  - o Differential charging for users and price capping for ANS Providers to incentivise stakeholders to meet the agreed timeline.
- All the above should be part of an economic scheme which reinforces the commitment for investment from all stakeholders.

## Legal Aspects

At a pragmatic level, **there should be no outright legal showstoppers** at European Level to the ATM Target Concept.

## The Role of the Human in ATM

It is identified that the changes in the operation of the future ATM System will involve a change in the human roles which requires an extensive **change management process** that integrates Human Factors, Social Dialogue and all relevant aspects of recruitment, training, competence verification and staffing proactively and throughout the entire process of system development, design and implementation.

The European Civil Aviation Sectorial Social Dialogue Committee is considered as a first promising step to have a European social dialogue, which could be expanded to cover more social provisions by way of collective agreements if social partners (at European level) so desire.

## Paving the way to the Master Plan

The SESAR Milestone Deliverable D5 is building upon the previous Milestone Deliverables D1-D4 providing the reference to support the decisions to build the Master Plan and launch the SESAR JU activities, including the development of the 2020 solution and research needed for the long term ATM Target Concept.

The SESAR Master Plan (D5) links and aligns the stakeholders programme activities to meet the agreed performance requirements and pave the way to the associated work-programme for 2008-2013 (D6).

## 9.2 Traceability Example

This section provides an example of Operational improvement steps and related enablers in the Master Plan.
The operational changes involved by the SESAR Concept of Operations will be carried out in an evolutionary and stepwise manner through "operational improvement steps" generating performance increments over time.

For instance, ASAS Sequencing and Merging (ASPA-S&M) is an operational improvement step (TS-0105) envisaged as part of Service Level 2 to increase capacity in Terminal Areas. The benefits come from a decrease in controller's task load and better synchronization of traffic to the runway, thus potentially decreasing holding and augmenting flight efficiency.

The operational improvement steps are aggregated per service level in the **operational roadmaps**.
Enablers are changes to systems, procedures, institutional aspects needed to realise the corresponding operational improvement step.

For instance, ASPA-S&M involves changes in the following areas (non exclusive list):

- Avionics (ref Aircraft-15 "Flight management and guidance to support ASAS spacing (ASPA)";
- Surveillance (ref CTE-S2b "ADS-B 1090 in/out (260A) to support full spacing e.g. S&M (step 3)";
- Communication (ref AGSWIM-46 "Datalink supporting dialogues and exchanges for ASAS S&M");
- Cockpit procedures (ref PRO-AC-15 "Cockpit Procedure for Airborne Spacing", PRO-AC-60 "Cockpit procedures for identifying target aircraft and manoeuvring a/c in compliance with responsibility to maintain spacing, PRO-AC-71 "Cockpit Procedures for Station-keeping associated with Arrival Management", PRO-133-"ATC procedures for identifying and issuing and ensuring compliance with ASAS spacing applications");
- ATC ground systems (ref ER-APP-ATC-61 "Adapt Controller and Local and Sub-regional Demand & Capacity Balancing tools to manage delegation of separation responsibilities to aircraft");
- Regulation and standards (ref ASAS-0201 "Update of ICAO PANS-ATM for Spacing Application", ASAS-0202 "New EUROCAE SPR and IOP Standards for Spacing Application", ASAS-0203 "Update ICAO Annex 10 for Spacing Application", LEG-05 "Domestic Legislation – to permit/require carriage/use of new/changed technologies").

These enablers are implemented by the concerned stakeholders through various activities, the nature of which depend on the phase of life-cycle considered (R&D, implementation, operation).

ASAS S&M concept, applications and procedures will be evaluated and validated by research centres while standardisation bodies will be developing the required standards (R&D phase). The implementation phase involves the approval of standards by the regulator, the production of capability level 2 avionics (based on validated requirements) by aircraft manufacturers as well the production of related capability level 2 ground systems by industry in compliance with the new standards. The national regulator will have to adapt legislation to permit carriage/use of capability level 2 equipment, and commercial operators will equip their fleet and train their aircrews to the related cockpit procedures. Likewise, air navigation service providers will upgrade their systems to the corresponding capability level 2 and ensure appropriate controllers' training. The operation phase starts after end-to-end integration of systems and switch to operation within a given geographical location (e.g. date of first capability level 2-equipped aircraft able to conduct ASAS-S&M in a TMA).

The system, procedural and institutional enablers are aggregated per capability level, system and stakeholder type in the **deployment roadmaps**.

Last but not least, the implementation of operational changes will have to be supported and facilitated by proper management processes. The following areas have been considered as deserving special attention: safety, security, environment, human performance and contingency. They require specific actions that are presented at high level in the **supporting roadmaps**.

## 9.3 Participating Stakeholder Groups

For the purpose of describing Stakeholder involvement in Master Planning the Stakeholders have been categorised as shown in Table 30 Stakeholder Categorisation. The table does not refer to the types of organisations, but to the roles that organisations can play. Organisations may be associated with multiple roles.

Some of the Stakeholders in this table are operating vehicles, systems and infrastructure that are involved in the provision or use of ATM Services. Their implementation roadmaps are contained in chapter 3. Other Stakeholders in Table 30 Stakeholder Categorisation are not directly involved in ATM operations. They are included because they play a role in standardisation and/or regulation.

| Stakeholder Category | Stakeholder Role |
|---|---|
| USER | USER Commercial Operators<br>(comprises Legacy Airlines, Low Fare Airlines, Regional Airlines) |
| | USER IFR Capable GA<br>(comprises Business Aviation (BA), High-End GA, VLJ Operators, IFR Helicopter Operators, factory demonstrations and flight trials etc.) |
| | USER VFR Only GA<br>(comprises Low-End GA) |
| | USER Military and State Aviation<br>(comprises GAT and OAT) |
| | USER UAV/UAS Operators<br>(comprises civil and military UAV/UAS operators) |
| AIRPORT Operator | AIRPORT Operator Civil |
| | AIRPORT Operator Military |
| ANS Provider | ANS Provider Civil<br>(comprises civil Airport, TMA and Enroute ANS Providers) |
| | ANS Provider Military<br>(comprises military Airport, TMA and Enroute ANS Providers) |
| | CNS Infrastructure Operator |
| Aeronautical Information Providers | Aeronautical Information Management |
| | Meteorological |
| | Others (e.g. A/C performance data..) |
| Regional Airspace and Network Manager | Airspace Manager |
| | Network Manager |
| Regional SWIM Manager | SWIM Manager |
| STANDARDISATION BODIES | STANDARDISATION BODIES National |
| | STANDARDISATION BODIES Int'l. |
| REGULATORY BODIES | REGULATORY BODIES National |
| | REGULATORY BODIES International |

Table 30 Stakeholder Categorisation

## 9.4 SESAR Performance Framework

The SESAR Performance Framework is structured around the 11 ICAO Key Performance Areas (KPAs). Details can be found in D2, which however has to be read in conjunction with subsequently published updates to this information (as a result of D3 and D4 activities) that are contained in the SESAR Definition Phase report "Performance Objectives and Targets" [Ref 13]. A high level overview is provided in Table 31 below.

The strategic performance objectives and targets represent the performance to be achieved in 2020. In a number of cases, intermediate (pre-2020) and long-term (post-2020) goals have also been defined. Some targets are at the level of total annual performance of the European ATM Network, others at hourly local level. In most cases, the objectives and targets specify the desired ATM outcome; in some specific cases they address internal ATM aspects, i.e. the need to improve the performance of certain management processes. Due to the different nature and maturity of the various KPAs, there is a mix of quantified requirements (i.e. objectives *with* performance targets) and qualitative requirements (i.e. performance objectives *without* quantitative targets).

| KPA | Objectives and Targets |
|---|---|
| Capacity | • **ATM Network capacity:** ability to accommodate 16 Million flights/year and 50,000 flights/day in Europe by the year 2020 (73% increase over 2005 traffic levels). The concept should be able to handle at least 3 times more traffic (en-route and airport network), so as to be able to handle traffic growth well beyond 2020.<br>• **Local airspace capacity:** The above are the average European design targets (at network level). When transposing this to local targets, regional differences will exist. The ATM target concept should be able to support a tripling or more of traffic where required.<br>• **Best-in-class declared airport capacity in Visual Meteorological Conditions (VMC):** 60 mov/hr (single RWY), 90 mov/hr (parallel dependent RWYs), 120 mov/hr (parallel independent RWYs). This represents an improvement of 20% with respect to current best-in-class performance.<br>• **Best-in-class declared airport capacity in Instrument Meteorological Conditions (IMC):** 48 mov/hr (single RWY), 72 mov/hr (parallel dependent RWYs), 96 mov/hr (parallel independent RWYs). This aims to reduce the gap between IMC and VMC capacity from 50% (2008) to 20% (2020).<br><br>Notes:<br>1. No best-in-class targets have been defined for complex airports (3 or more runways). These airports will have to be looked at individually.<br>2. Capacity varies in function of the chosen/accepted trade-offs with performance degradation in other KPAs. All capacity targets above are to be understood as the maximum throughput that can be achieved while still respecting the targets for Safety and QoS (Quality of Service): Efficiency, Flexibility and Predictability. |
| Cost Effectiveness | • **Total annual en-route and terminal ANS cost in Europe (gate-to-gate ATM cost):** the 2004 baseline was €7,000M for 8.7 million flights (€800/flight). In 2020, this total annual cost should stay below €6,400M for 16 million flights (€400/flight, a reduction of 50% per flight). Baseline and 2020 target are expressed in 2005 euros. |
| QoS: Efficiency | *For those airspace users ready to fly as initially planned (Initial Shared Business Trajectory), the performance objectives and targets for 2020 are:*<br>• **Better departure punctuality:** 98% of flights departing as planned (3 min tolerance); for the other flights, the ATM delay should be less than 10 minutes (on average);<br>• **Less deviation from the planned block-to-block time:** 95% of flights flown as planned (3 min tolerance); for the other flights, the block-to-block extension should be less than 10 minutes (on average);<br>• **Improved fuel efficiency:** 95% of flights flown with fuel consumption as planned (2.5% tolerance); for the other flights, additional fuel consumption should be less than 5% (on average).<br><br>*For the military airspace users who conduct training activities:*<br>• **Reduce the economic impact of transit:** measured as the total cost of transit from base to training area and back;<br>• **Improve the impact of airspace location on training efficiency:** more time spent actually in the designated operating area, achieving the mission training objectives, compared with the total time airborne. |

| KPA | Objectives and Targets |
|---|---|
| QoS: Flexibility | *For VFR flights, the performance objectives and targets for 2020 are:*<br>• **Improved accommodation of VFR-IFR change requests:** 98% of such requests should be accommodated without delay penalties.<br><br>*For unscheduled IFR flights (users not providing early notification of flight intentions), the performance objectives and targets for 2020 are:*<br>• **Better on-time departure:** 98% of flights departing as requested (3min tolerance); for the other flights, the delay should be less than 5 minutes (on average).<br><br>*For those airspace users unable to fly as initially planned, i.e. requesting late changes to the original plan, the performance objectives and targets for 2020 are:*<br>• **Increased accommodation of new departure time for scheduled flights:** 98% of these flights departing as requested (3min tolerance); for the other flights, the imposed delay should be less than 5 minutes (on average);<br>• **Increased accommodation of new departure time, route, level and/or destination for scheduled and unscheduled flights:** 95% of such requests accommodated. Of these flights, 90% should be accommodated without imposing departure or arrival delays (3min tolerance); for the other flights, the imposed delay should be less than 5 minutes (on average).<br><br>*For all airspace users, there are additional objectives related to flexibility:*<br>• **Keep the number of flexibility requests (see above) as low as possible** (in relation to the total volume of traffic);<br>• **Inform the ATM System of the flexibility requests (see above) as early as possible.**<br><br>*With regard to the suitability of the ATM System for military requirements related to the flexibility in the use of airspace and reaction to short-notice changes:*<br>• **Improve the ability to increase/decrease the amount of airspace segregation** as required;<br>• **Maximise adherence of military training activities** to optimum airspace dimension;<br>• **Improve the utilisation of segregated airspace** by military training activities;<br>• **Improve the actual airspace usage** by military users compared with that booked by planners;<br>• **Increase** the amount of time that **training in non-segregated airspace** is possible;<br>• **Improve the release of airspace** by military users. |
| QoS: Predictability | *At European annual level, the predictability objectives and targets for 2020 are:*<br>• **Less variation in the actual block-to-block times:** for repeatedly flown routes using aircraft with comparable performance, the statistical distribution of the actual block-to-block times should be sufficiently narrow: standard deviation less than 1.5% of the mean value for that route;<br>• **Better arrival punctuality:** 95% of flights arriving as planned (3 min tolerance); for the other flights, the delay should be less than 10 minutes (on average);<br>• **Less reactionary delay:** with respect to the total number of flights, reduced total amount of delay caused by the late arrival of the aircraft or the crew from previous journeys (between 2010 and 2020: 50% improvement);<br>• **Less reactionary flight cancellations:** with respect to the total number of flights, reduced percentage of cancellations caused by the late arrival of the aircraft or the crew from previous journeys (between 2010 and 2020: 50% improvement);<br>• **Less service disruption delay:** with respect to the total number of flights, reduced total amount of delay caused by service disruption (between 2010 and 2020: 50% improvement);<br>• **Less service disruption diversions:** with respect to the total number of flights, reduced percentage of diversions caused by service disruption (between 2010 and 2020: 50% improvement);<br>• **Less service disruption flight cancellations:** with respect to the total number of planned flights, reduced percentage of cancellations caused by service disruption (between 2010 and 2020: 50% improvement). |
| Safety | Ensure that the numbers of **ATM induced accidents and serious or risk bearing incidents** (includes those with direct and indirect ATM contribution) **do not increase** and, where possible, decrease.<br>As traffic increases, this implies the requirement to **improve safety levels** by a factor 3 between 2005 and 2020, and by a factor 10 in the longer term. |

| KPA | Objectives and Targets |
|---|---|
| Security | • **Improve ATM Self Protection:** introduce improvements in managing the risk, the prevention, the occurrence and mitigation of unlawful interference with flight operations of civil aircraft and with ATM service provision (e.g. via attacks compromising the integrity of ATM data, services, facilities and staff). ATM Self Protection also includes the prevention of unauthorised access to and disclosure of ATM information;<br>• **Improve Collaborative Security Support:** provide improved support to State institutions / agencies that deal with in-flight security incidents and to respond effectively to such incidents when they happen. |
| Environmental Sustainability | *To meet society's expectation to reduce the environmental impact of aviation, a collective effort is required from all Stakeholders in the European air transport industry. The "Clean Sky" JTI (Joint Technology Initiative) of the EC will accelerate the introduction of green technologies in new generation aircraft for a sooner green aviation[18], whereas the aim of SESAR is to complement this by improved air traffic services resulting in flight operations which are better optimised from an environmental sustainability perspective. The latter has been translated into the following SESAR performance objectives:*<br>• **Achieve emission improvements** as an automatic consequence of the reduction of gate-to-gate excess fuel consumption addressed in the KPA Efficiency. The SESAR target for 2020 is to achieve 10% fuel savings per flight as a result of ATM improvements alone, thereby enabling a 10% reduction of $CO_2$ emissions per flight;<br>• **Improve the management of noise emissions and their impacts:** to ensure that these are minimised for each flight to the greatest extent possible;<br>• **Improve the role of ATM in *enforcing* local environmental rules:** ensure that flight operations comply 100% with aircraft type restrictions, night movement bans, noise routes, noise quotas, etc. Ensure that exceptions are only allowed for safety or security reasons;<br>• **Improve the role of ATM in *developing* environmental rules:** The aim is to ensure that all proposed environmentally related ATM constraints will be subject to a transparent assessment with an environment and socio-economic scope; and, following this assessment the best alternative solutions from a European Sustainability perspective are adopted. |
| Access and Equity | *Improve access:*<br>• Ensure that **shared use of airspace and airports** by different classes of airspace users **will be significantly improved** (classes defined by type of user, type of aircraft, type of flight rule);<br>• **Where shared use is conflicting** with other performance expectations (safety, security, capacity, etc.), ensure that **viable airspace/airport alternatives will be provided** to satisfy the airspace users' needs, in consultation with all affected stakeholder (see Participation KPA).<br>*Improve equity:*<br>• **For priority management,** ensure that **more options** will be available than just the 'first come first serve' rule;<br>• Ensure that **priority rules will always be applied in a transparent, correct manner.** |
| Interoperability | Ensure that the **application of standards and uniform principles,** together with **improved technical and operational interoperability** of aircraft and ATM Systems will **enable a measurable improvement** of:<br>o The efficiency of business trajectories for intra-European and intercontinental flights;<br>o Airspace and airport related access for intra-European and intercontinental flights;<br>Airspace and airport related equity for intra-European and intercontinental flights. |
| Participation | • **Improve participation by the Stakeholders / ATM Community:**<br>o During planning, development, deployment, operation and evaluation/improvement of the ATM system<br>o For all performance areas: access and equity, capacity, cost effectiveness, efficiency, environment, flexibility, interoperability, predictability, safety, security<br>o By involvement of all ATM community segments<br>o While respecting all applicable rules, regulations and legislation |

18 The purpose of Clean Sky is to demonstrate and validate the technology breakthroughs that are necessary to make major steps towards the environmental goals sets by ACARE - Advisory Council for Aeronautics Research in Europe - the European Technology Platform for Aeronautics & Air Transport and to be reached in 2020: 50% reduction of $CO_2$ emissions through drastic reduction of fuel consumption; 80% reduction of $NO_x$ emissions (Nitrogen Oxides); 50% reduction of external noise; A green product life cycle: design, manufacturing, maintenance and disposal / recycling. (source: www.cleansky.eu)

| KPA | Objectives and Targets |
|---|---|
| **Participation (cont'd)** | • **Choose the most appropriate (combination of) method(s) and level of involvement** (depending on the circumstances):<br>o informing the community,<br>o obtaining feedback and advice from the community,<br>o collaborative decision making (CDM),<br>o consensus building.<br>• **Establish focused tracking** of the various participation and involvement initiatives, **assessment of** the **actual** level of involvement against the **desired** level, and **identification of weaknesses and improvement opportunities.** The aim is to **achieve a balanced approach** to ATM community involvement. |

Table 31 Strategic Performance Objectives and Targets

D3 describes the ATM target concept that has been developed in the SESAR Definition Phase to respond to these performance requirements. An assessment has then been conducted to develop confidence that the target concept is capable of meeting these requirements. The results are summarised in chapter 4.

## 9.5 Relationship between SWIM and ATM Performance

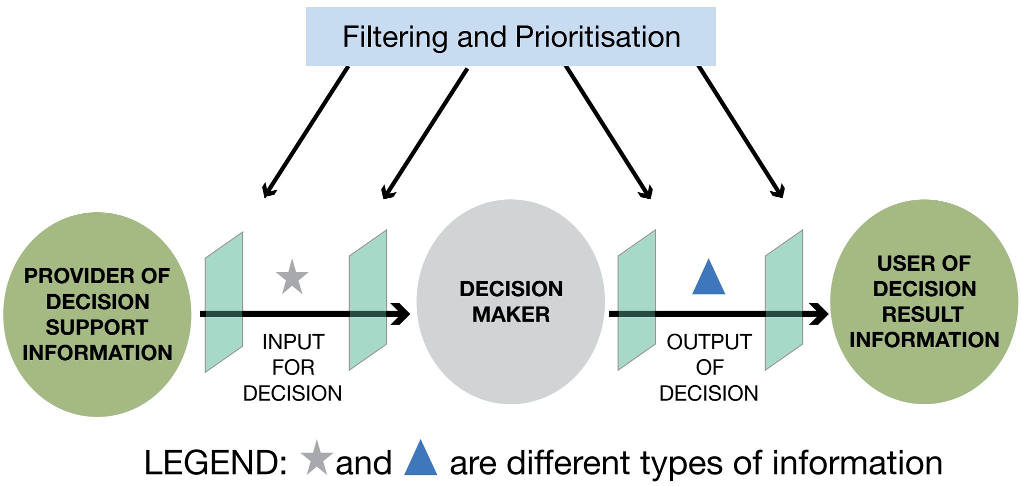


Figure 53: Interaction between Information Providers, Decision Makers, and Information Users

From a generalised "command and control" perspective, the ATM system can be seen as a complex, distributed real-time information processing community populated by a large number of humans and automated systems in the role of sensors, information providers, information users and decision makers, all collaborating to ensure a safe, expeditious and efficient flow of air traffic.

As is illustrated in Figure 53, the performance of ATM depends on six factors:

1. Existence of airborne and ground-based suppliers (systems and service providers) for the various types of ATM decision support information;
2. Availability, quality and timeliness of the provided decision support information (quality includes integrity, accuracy, completeness, legibility, trustworthiness etc.);
3. Ability of airborne and ground-based ATM decision makers to receive, absorb and use available information;
4. Quality and timeliness of the airborne and ground-based decision making itself;
5. Effectiveness and timeliness of making the resulting ATM decision information available to (potential) airborne and ground-based consumers of that information (those who have to act on it);
6. Effective information filtering and prioritisation along the way.

In order to improve overall ATM performance, all six factors need to be improved.
Historically, the focus of attention has primarily been on item 4 — how to improve (algorithms, automated tools and procedures for) decision making in the various functional categories e.g. airspace management, flow and capacity management, separation assurance, sequencing and metering etc. — whereas the purpose of the *information management* perspective is complementary. It focuses (exclusively) on improving the other five factors that are equally determining how well ATM performs at the end of the day.
System Wide Information Management (SWIM) will introduce a number of changes that are specifically designed to improve these other five factors. The final effect of the evolution towards SWIM is illustrated in Table 32, which contrasts the information management situation before and after deployment of SWIM.

| ATM information management prior to SWIM | Target situation after SWIM deployment |
|---|---|
| Has roots in the traditional ATM environment where CNS limitations were the main determinant for what was possible | Applicable to a fully networked information-rich ATM environment |
| Focus on “micro-management” of information | Challenge: how to deal with large quantities of information |
| Interaction between decision makers is through communication (mainly point-to-point information flows) | Interaction between decision makers is through information sharing, i.e. via a distributed "virtual" information pool which uses concepts such as information replication, information caching, etc. |
| Real-time event propagation amongst ATM stakeholders occurs through message exchanges (send/receive) generated at decision making level, not at information management level | Real-time event propagation amongst ATM stakeholders is managed by a separate information management layer: triggered by information filters (publish/subscribe) and the dynamics of the information web, i.e. by synchronisation of information state & relationship changes in the various copies of the information |
| Emphasis is on interface definition and standardisation in a static environment (development and acceptance of information architecture standards takes years) | Emphasis is on information standardisation in a rapidly evolving environment (advanced systems know how to adapt to new meta-information — this is the key to quick responses to changing information needs) |
| Most meta-information is embedded (hidden) in system designs and information architecture standards | Extensive amounts of explicit meta-information are circulating in the ATM system |
| Systems follow a classic design which enforces a rigid structure of information flows (functional architecture with "hardwired" data flow diagrams, i.e. static view of inputs and outputs of a function) | Systems are designed to support flexible information flows (not based on pre-defined data flow diagrams, but on predictive, dynamic information demand/supply balancing — capable of adaptation to the "information market") |
| Information management principles are applied at the local (system) level only (leads to islands of information) | ATM network characterised by the existence of common processes explicitly responsible for system-wide information management (leads to a coherent system-wide integrated web of distributed information: the ATM virtual information pool) |
| ATM is characterised by integration and interoperability problems | Integration and interoperability problems in ATM are solved by efficient information sharing capabilities |
| Information ownership, licensing, pricing and security are poorly addressed | Information has become a commodity: information ownership, licensing, pricing & security mechanisms have matured (for static as well as real-time information) |

Table 32 Information Management before and after SWIM deployment

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