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.

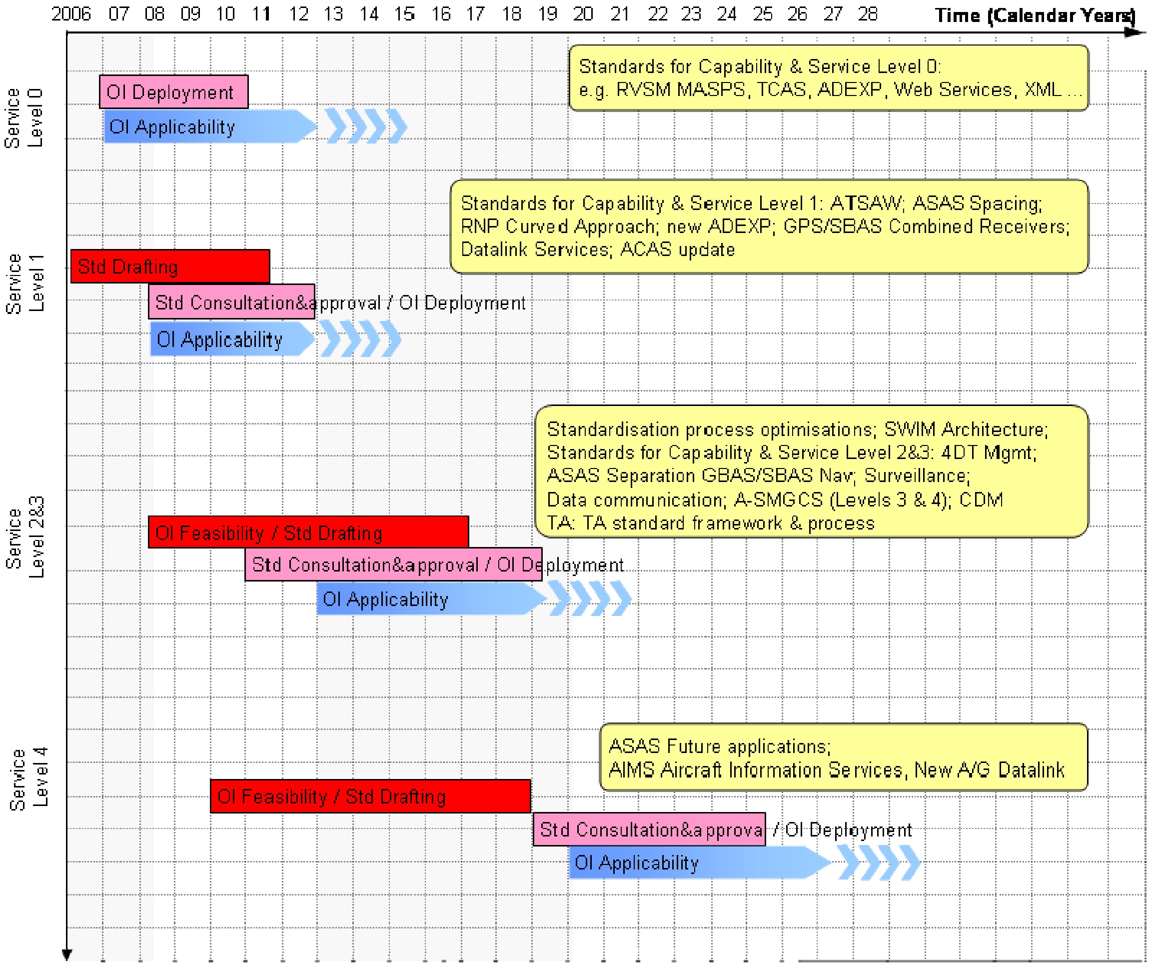

Figure 1 Standardisation roadmap

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).

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). 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). 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. Derive requirements for VoIP (radio). Develop an optimised standardisation process (stakeholder participation, CS selection process, CS assignment, complexity); Develop an ATM Supporting Area standardisation framework and process. 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. 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. Derive requirements for IP network and New airport WIMAX surface Datalink. 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. Monitor the compatibility and consistency of the SESAR concept with ICAO and subsequently launch the necessary actions.

Integrated Management System Roadmaps

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.

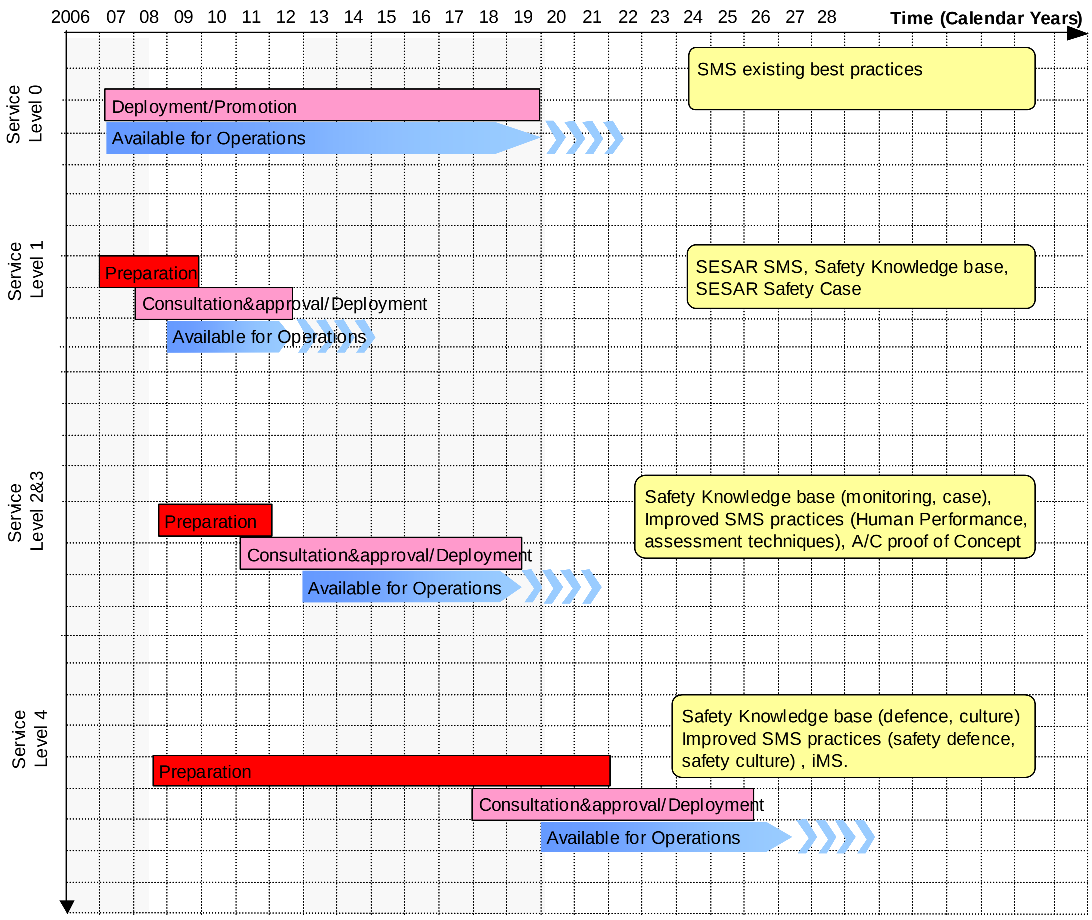

Figure 2 Safety roadmap

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. Develop new models (e.g. top-down accident-incident model, Safety Target Achievement Roadmap (STAR), true separation assurance, and Barrier Safety Model for Airports). 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). 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). 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. Safety Register Management Tool. 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). Develop Resilience Engineering and layered safety defences Paradigms. Investigate Safety Intelligence paradigm which aims to ensure that safety motivation can be most effectively channelled at all levels in the organisation. Develop a complexity-safety model (when complexity becomes unsafe) and 'de-complexifying' ways of displaying information to controllers. 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). Develop Human Performance Envelop Modelling. Develop the principle of 'proof of Concept' for Aircraft certification.
Service Level 2&3 Enablers
Global safety monitoring system. 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. 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. Recognised Acceptable Means of Compliance, when required.

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.

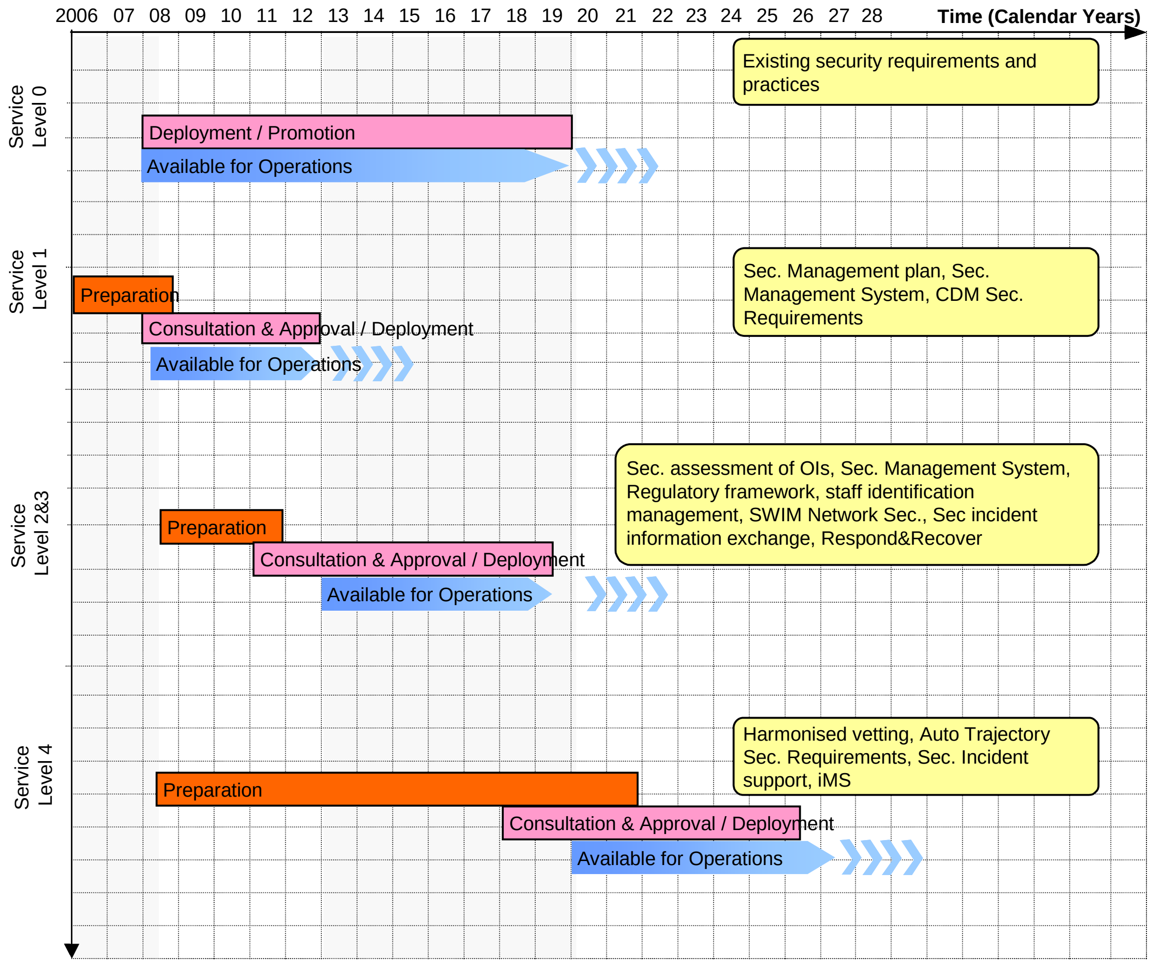

Figure 3 Security roadmap

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. Develop proposal for security governance in Europe. Develop and validate security Compliance Framework for security validation. 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. Develop and validate method and tools to support security assessment. Define and validate standards for Staff Identification. Develop and validate a Security Incident Information Exchange. Develop and validate Incident Support. Define and validate Respond and Recover process. Develop and validate standards for assurance of Data Confidentiality Level. Define and validate requirements for accountability for information and authentication. 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 Develop methods and tools to support Auto Trajectory security assessment Develop ATM Security Regulation at ICAO and European level taking into consideration Best Practices. Develop and produce standards for Access and Vetting to support ATM Security Operations/Security Service

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.

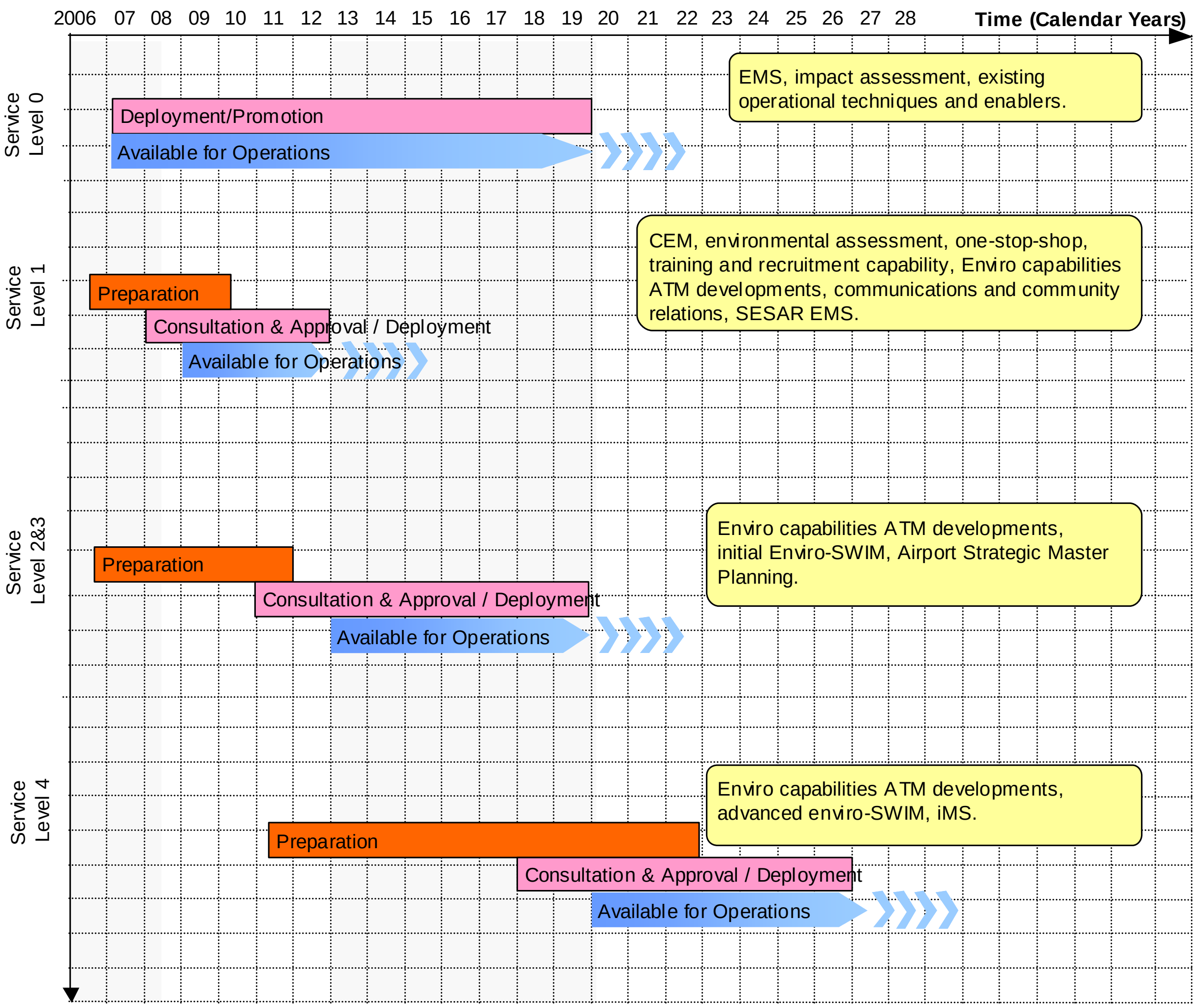

Figure 4 Environment roadmap

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. Develop ATM's understanding of it aspects, effects and impacts in a socio-enviro-economic scope. Develop Collaborative Environmental Management (CEM) and Environmental Management Systems (EMS) implementation support resources. Develop best practice based guidance on airport strategic master planning - integration with land-use planning and possible supervisory instruments. Develop training and awareness resources to support the environmental sustainability skill needs for ATM. 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. 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. 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. 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.

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.

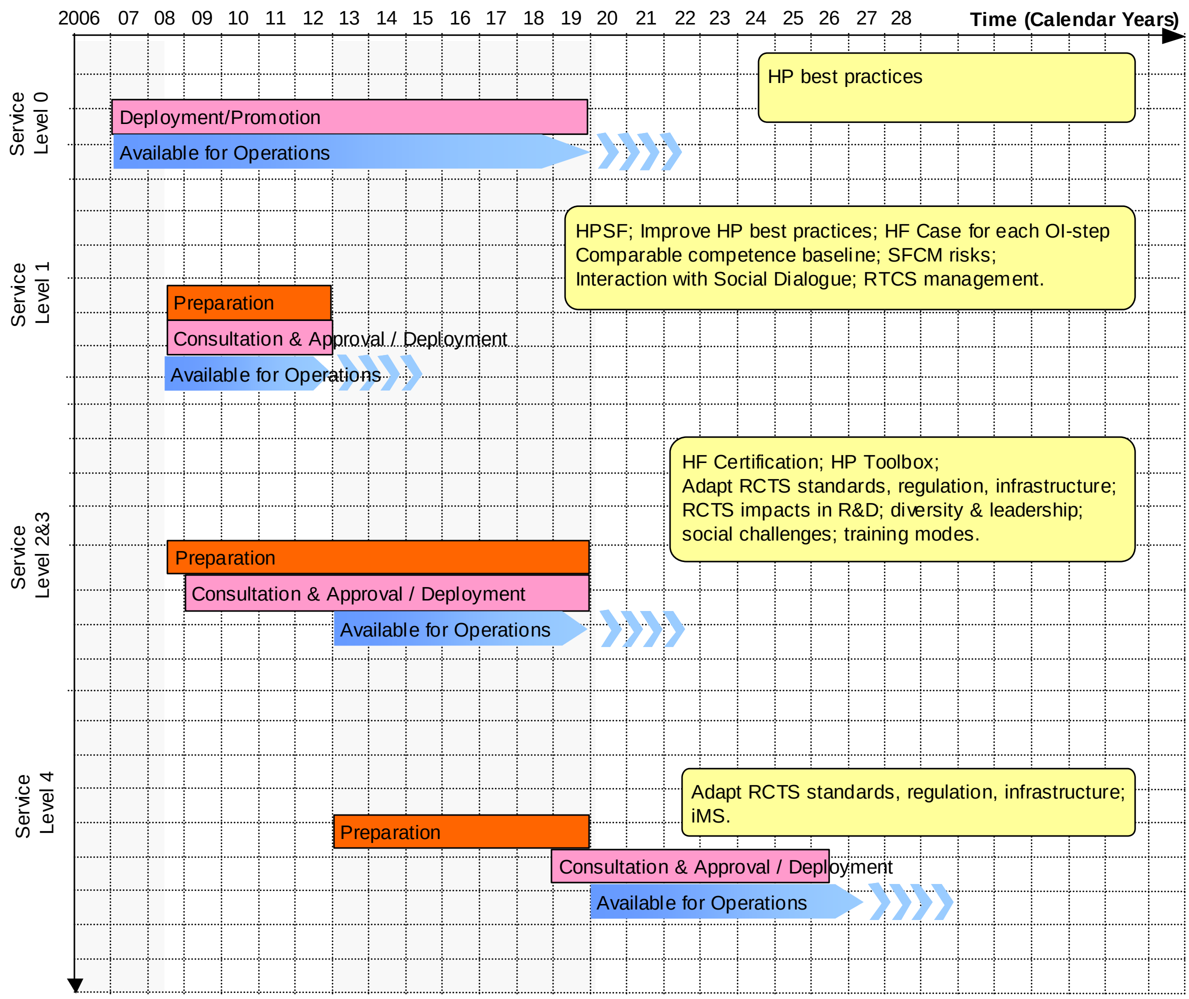

Figure 5 Human Performance roadmap

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 - Further develop and validate HF Case methodology including guidance and training material. - Develop plan to improve implementation of human performance best practices. Recruitment, Training, Competence and Staffing related preparation - Develop enhanced comparability of operational competence through new and refined standards. - 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). - Define safety criticality of Human tasks and a rationale for the degree of regulation for training and competence. Social Factor and Changes Management related preparation - Develop guidelines and tools for systematic change management and its social consequences. - 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 - Develop and validate top-down SESAR functions analysis, including development of automation classification scheme and automation (failure) strategies. - Define new roles and responsibilities for future staff. - Optimise trade-off between advance planning and the necessary flexibility of SESAR system dealing with unexpected events or degraded modes. Recruitment, Training, Competence and Staffing related preparation - Systematic examination of RTCS impacts in all SESAR R&D supported by standard methodology. - Develop interdisciplinary training processes for enhanced CDM and network management. - Develop a classification of simulation tools for ATM training oriented along SESAR capability levels. - 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). - Develop training simulation standards and certification aligned to SESAR capability levels. Social Factor and Changes Management relate preparation - Develop processes and models to enhance participation of affected personnel. - 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 - Define appropriate mechanisms for task delegation and authority sharing. Recruitment, Training, Competence and Staffing related preparation - Develop enhanced competence schemes for operational ATM staff in highly automated environments. - Timely examination of quantitative staffing impacts of very advanced systems and procedures. - 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. Social Factor and Changes Management related preparation - Develop a framework for transferability and mobility of Civil Aviation staff. - Develop common objectives in social policies for Civil Aviation. - Develop a framework for future social challenges & change management.

Contingency planning for ANS/Airport deployment activities

Two aspects of contingency[1] 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").

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[1] 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*".

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.

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 **Fehler! Verweisquelle konnte nicht gefunden werden.**, except for SWIM supervision as explained in the introduction of Chapter 3.

Users (Aircraft Operators) – Aircraft

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.

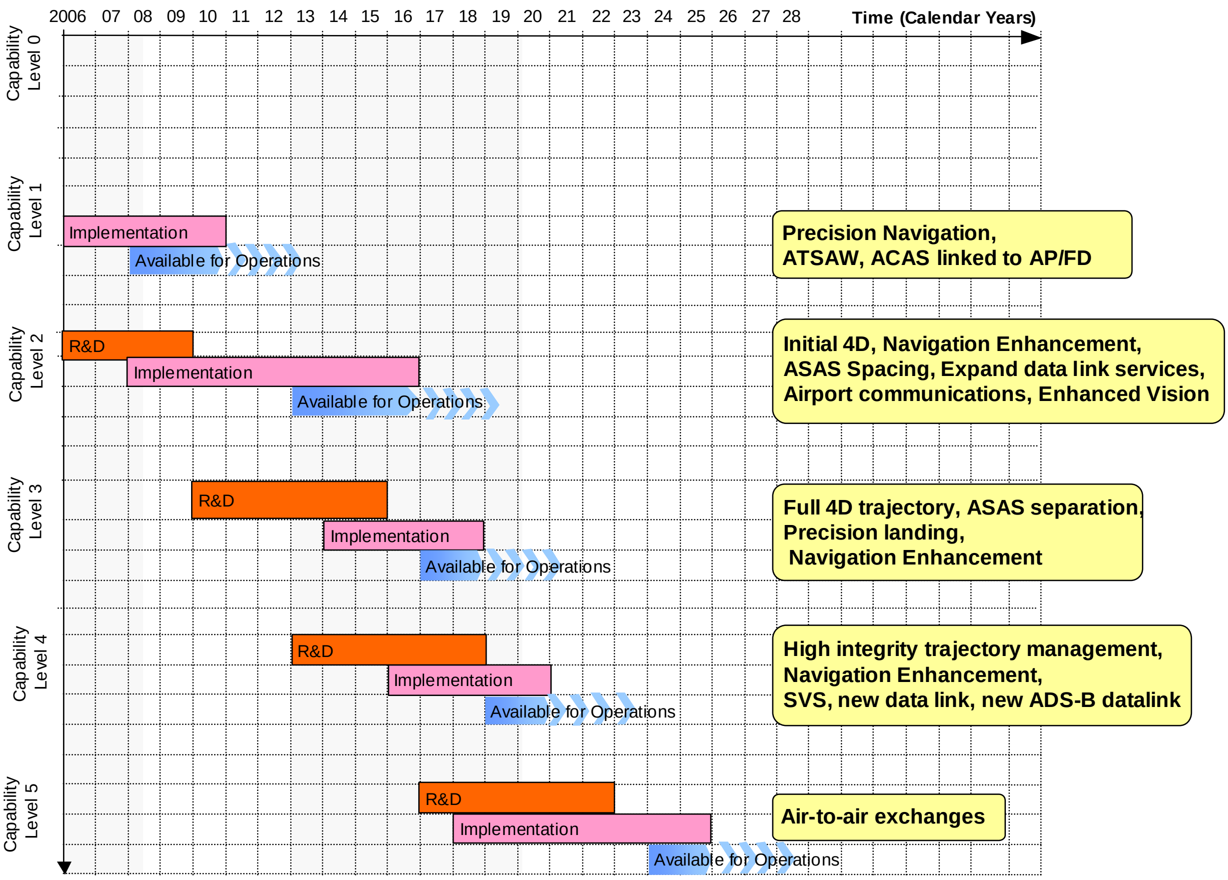

Figure 6 Users Transport Aircraft – Aircraft roadmap

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 LoC#5 Managing Business Trajectories in Real Time 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	LoC#8 New Separation Modes LoC#10 Airport Throughput, Safety and Environment

implementation of **1090 ADS-B IN** to receive other aircraft position/vector. This enablers the implementation of ATSAW-AIRB, ITP, VSA and SURF applications.	
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 communications (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 Controlled Time of Arrival (CTA) – time constraint on a defined merging point associated to an arrival runway; Precision Trajectory Clearances (PTC-2D), and Trajectory Control by Ground Based Speed Adjustment; Uplink of ATC constraints and downlink of 4D data.	LoC#2 Moving from Airspace to Trajectory Based Operations LoC#5 Managing Business Trajectories in Real Time LoC#7 Queue Management Tools 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 separation 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 LoC#10 Airport Throughput, Safety and Environment
Airport Communications: introduce new airport wireless Datalink (802.16 based) capability.	LoC#10 Airport Throughput, Safety and Environment
EVS: Enhanced vision (EV) of terrain and runway on head up	LoC#10 Airport

display (HUD) in Low Visibility Conditions to facilitate approach and ground operations.	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. Develop and validate the techniques to improve the accuracy of positioning on airport surface also reliability of obstacle detection. Update ABAS system to take on-board new GNSS capability to improve current IRS and GNSS performance. By 2011, investigate, design, prototype airborne GNSS receiver capabilities. Develop and validate the air and ground components technical 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). Develop and validate flight management and flight deck capabilities to support ASAS spacing applications. Develop and validate 802.16 based Airport Datalink. 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: data sharing; ground broadcast of Uplink of AIMS/Meteo data (wind grids); 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; 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 LoC#7 Queue Management Tools 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	LoC#10 Airport Throughput, Safety

sub-metric surface movement positioning.	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. 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. Develop and validate the required performance of ADS-B receivers to support ASEP operations. Develop and validate GBAS Cat III for precision landing; exploit infrastructure for high precision surface navigation and guidance. 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 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	LoC#8 New Separation

complement to ADS-B 1090.	Modes

Capability Level 4 Required R&D
Investigate the conformity of military aircraft with vertical performance navigation requirements. 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. Develop and validate architecture to integrate wake vortex detection with ASAS applications. 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, Assess the potential of infrared LED airport lighting to support ground surface operations. Develop and validate requirements for new Datalink. Validate feasibility based on L Band terrestrial Datalink and Satellite Based communication. 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: New Airborne Separation Modes (ASAS Self Separation); 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, Air broadcast of weather hazards.	LoC#1 Information Management 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	LoC#8 New Separation Modes

separation with all other aircraft.	
Capability Level 5 required R&D	
Define requirements, develop and validate air-air point-to-point communications architecture. Develop and validate architecture to integrate wake vortex detection with ASAS applications. 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).	

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).

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.

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.

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.

Users (Aircraft Operators) – Flight Operations Centre

This roadmap covers all improvements required for the Airspace User Flight Operations Centre[2].

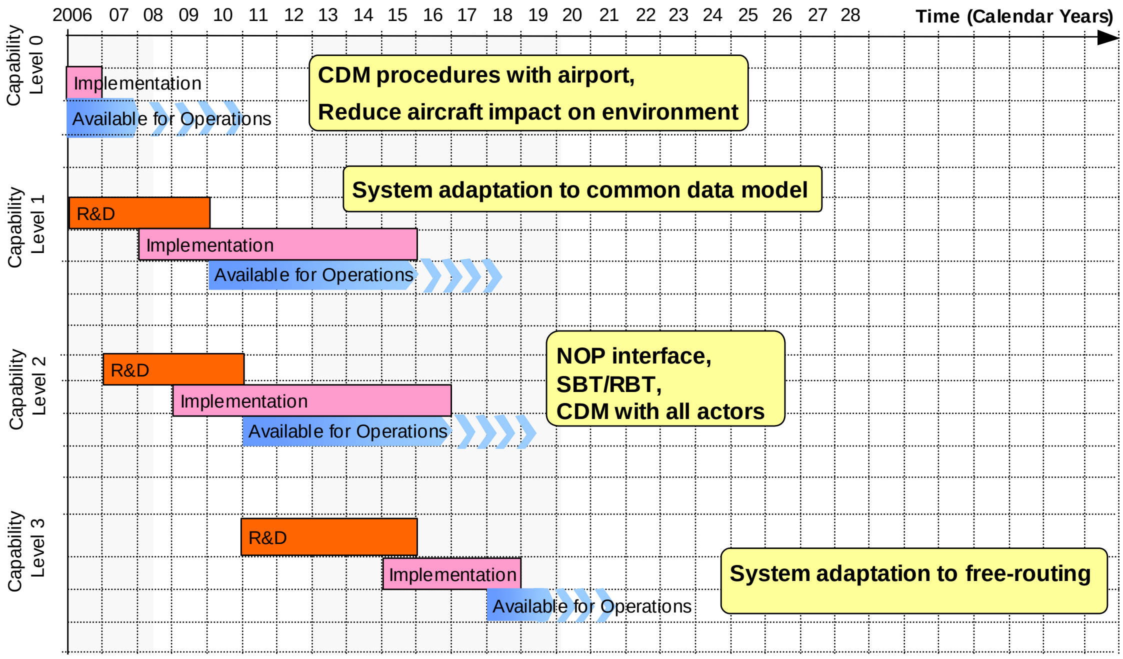

Figure 7 Users (Aircraft Operators) – FOC[3] roadmap

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

[2] Flight Operation Centre is a generic term covering Airline (or Wing) Operation Centre (AOC) ATM and Airspace User agent.

[3] for the case of Military Mission Trajectories similar capability/service might have to be available in Wing Operations Centres or other Military Centres

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
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 LoC#8 New Separation Modes
Capability Level 3 Required R&D	
Develop and validate FOC systems requirements to be able to propose free-route.	

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.

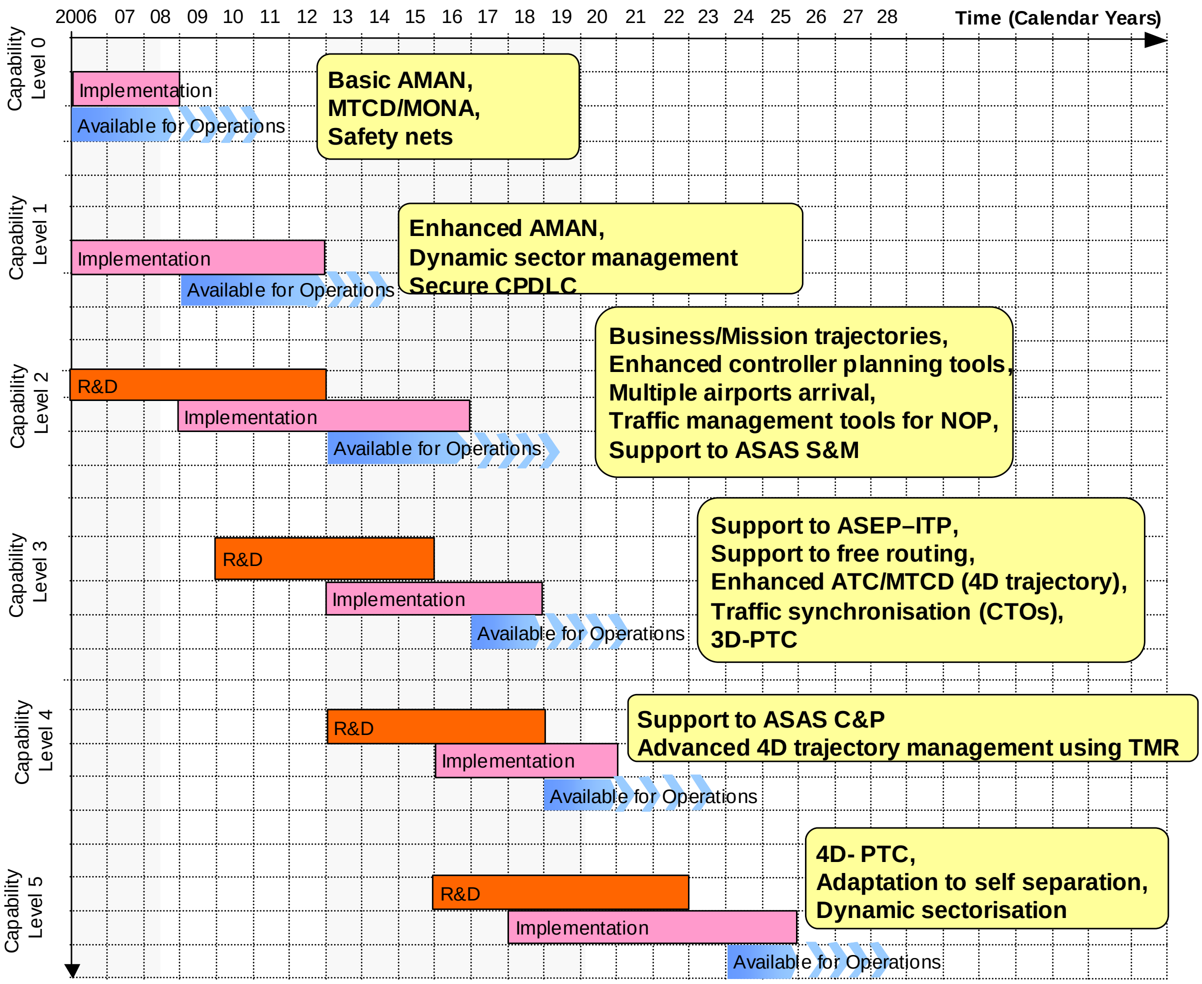

Figure 8 ANS Providers – ENR/APP ATC roadmap

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 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. 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 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.	

Develop tools and procedures for supporting controllers in handling free routing, with specific care of human aspects.

Define and validate ATC processes and tools to manage the various states of the Business Trajectory, transitions, segment clearances and RBT revisions.

Define and validate tools and processes to support complexity assessment and resolution at the level of ATC.

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.

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.

Define and validate ground tools to support ASAS Sequencing & Merging.

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 LoC#6 Collaborative Ground and Airborne Decision Making Tools 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. Adapt ground Safety Nets to new separation modes and integrate down linked resolution advisories. 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. 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. Define and validate the ground and air capabilities and associated procedures to support the use of 4D-PTC in En-Route airspace.	

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.

Airport ANS Provider - Aerodrome ATC system

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

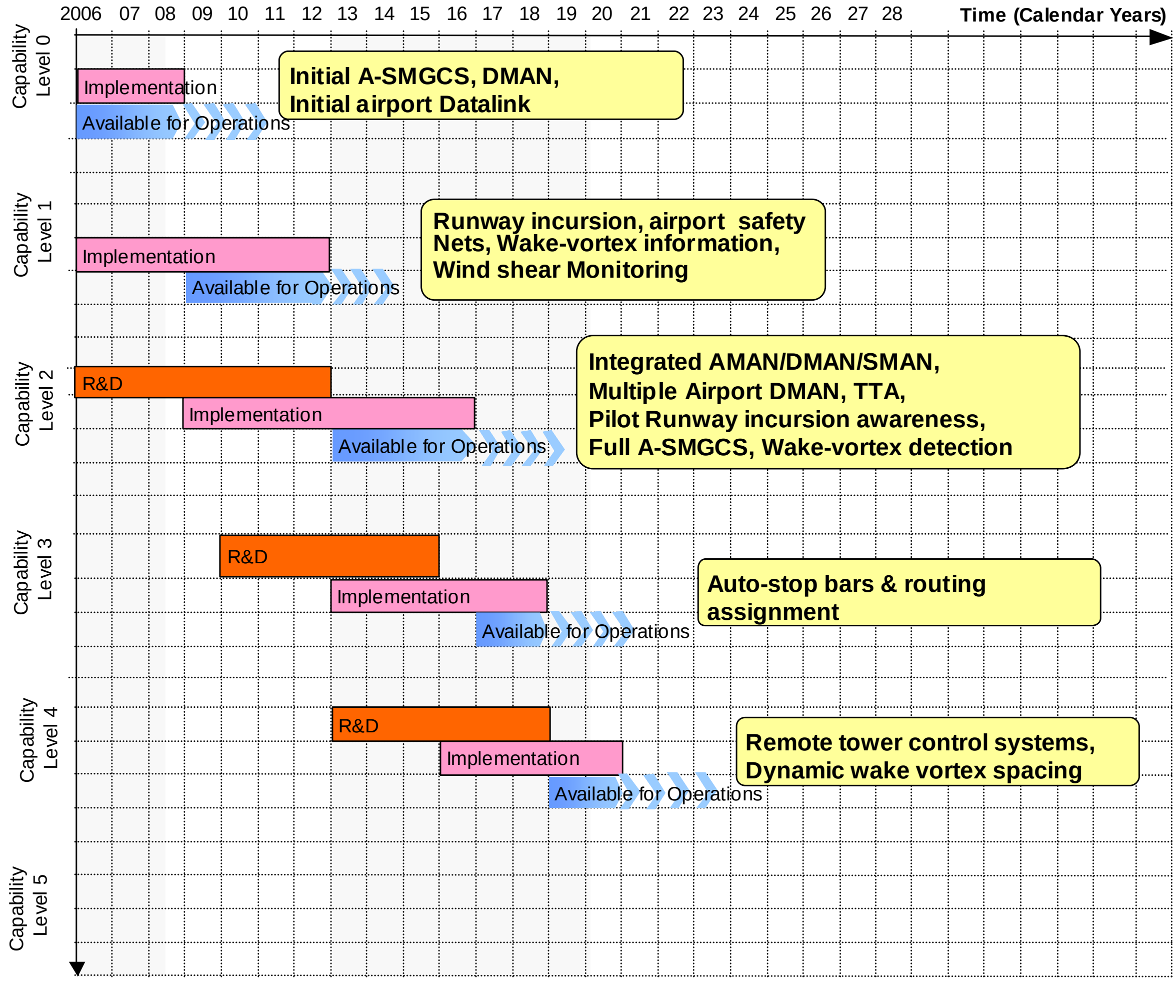

Figure 9 ANS Provider – Aerodrome ATC roadmap

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 communications (but not replacing them).	LoC#1 Information Management
Capability Level 1 Required R&D	
Completed.	

Capability Level 2 Deployment	
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	LoC#10 Airport Throughput, Safety and Environment

guidance).	
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. Develop and validate processes supporting CDM in order to ensure efficiency of the processes and benefits for the network. Develop and validate use of glide path guidance and runway threshold/touchdown markings for safe "Land long" Hi/Lo glide path operations. Develop and validate means to coordinate pre-selected runway exit between ground controller and flight crew. 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[4].	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

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

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.

Airport Operator -– Airport Airside Operations Systems

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

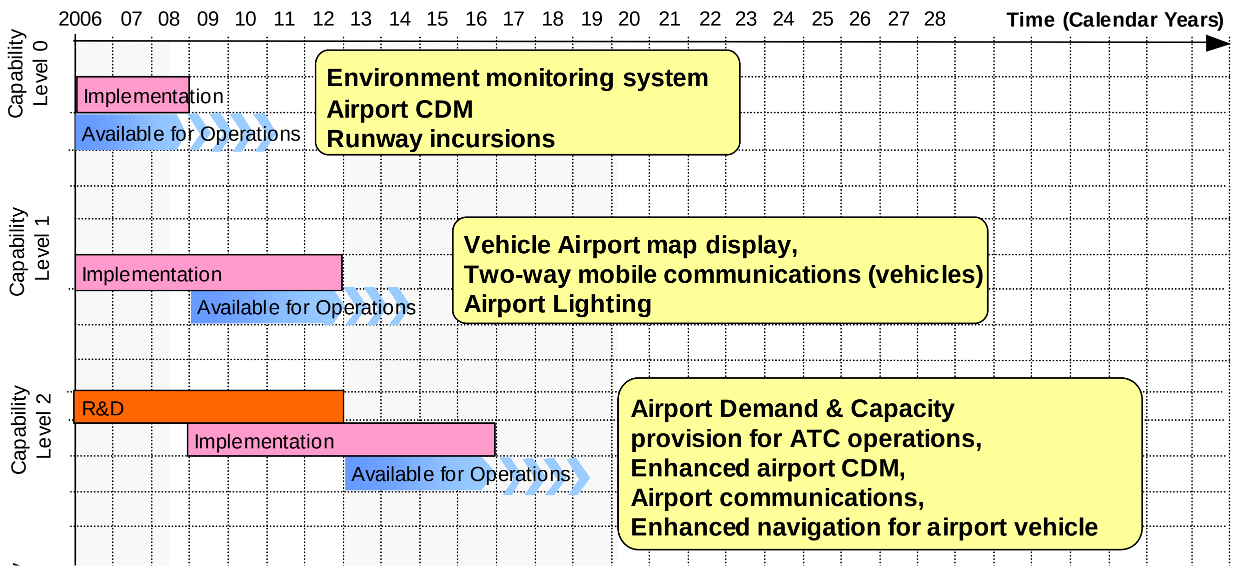

Figure 10 Airport Operator – Airport Airside Operations roadmap

Capability Level 0 Deployment	Supports Line of Change
Environment monitoring system: deploy system to monitor noise, air quality, and emissions. **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.	LoC#10 Airport Throughput, Safety and Environment

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. Develop and validate system enhancement to support the management of traffic complexity to improve airport surface operations.	

Regional Airspace and Network Manager

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.

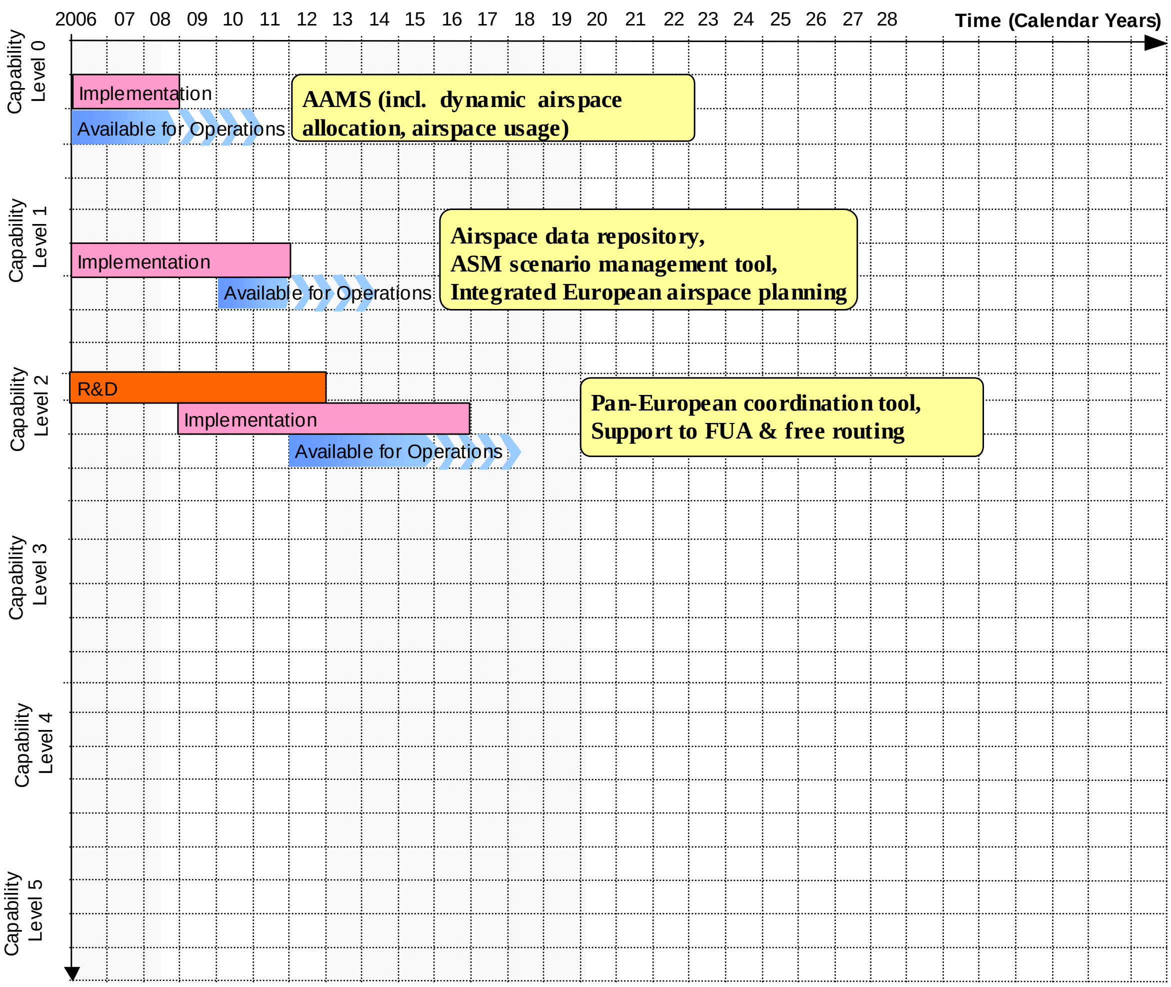

Figure 11 Regional Airspace Manager – AAMS roadmap

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 LoC#3 Collaborative Planning using the NOP

Capability Level 1 Deployment	Supports Line of Change
Airspace data repository: implement a common and consistent	LoC#2 Moving from

source of airspace information for Regional Information Management, National/Local system, and European aeronautical database.	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. 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.	

Regional Network Manager - NIMS

This enabler roadmap proposes enhancements related to Network Information Management System.

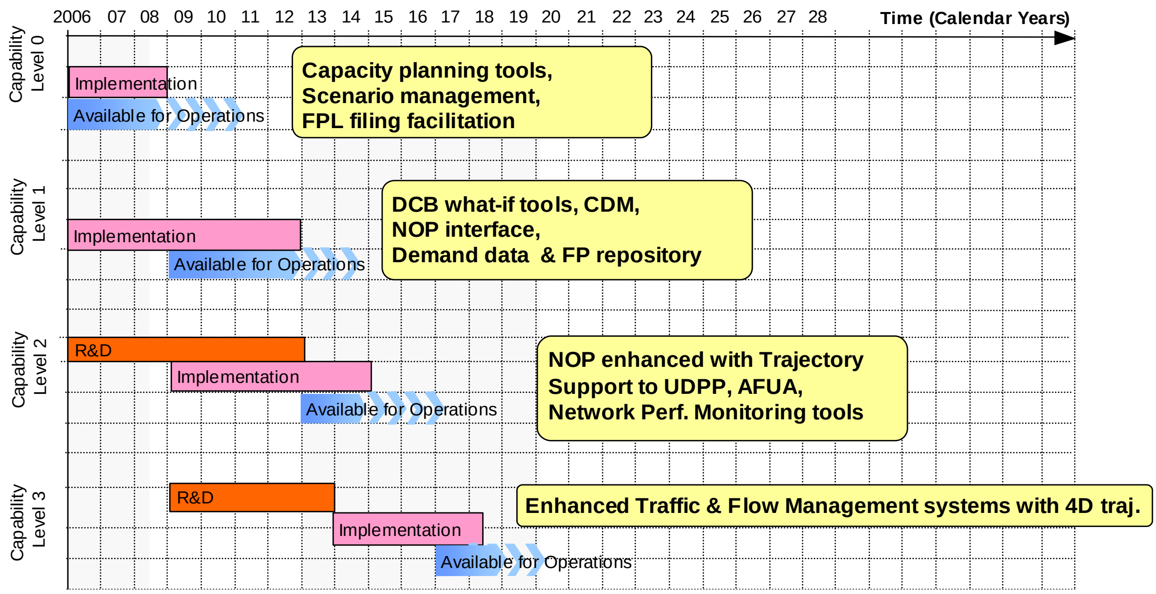

Figure 12 Regional Network Management - NIMS roadmap

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 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 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 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 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. 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).	

CNS Infrastructure Operator - CNS Systems and Infrastructure

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

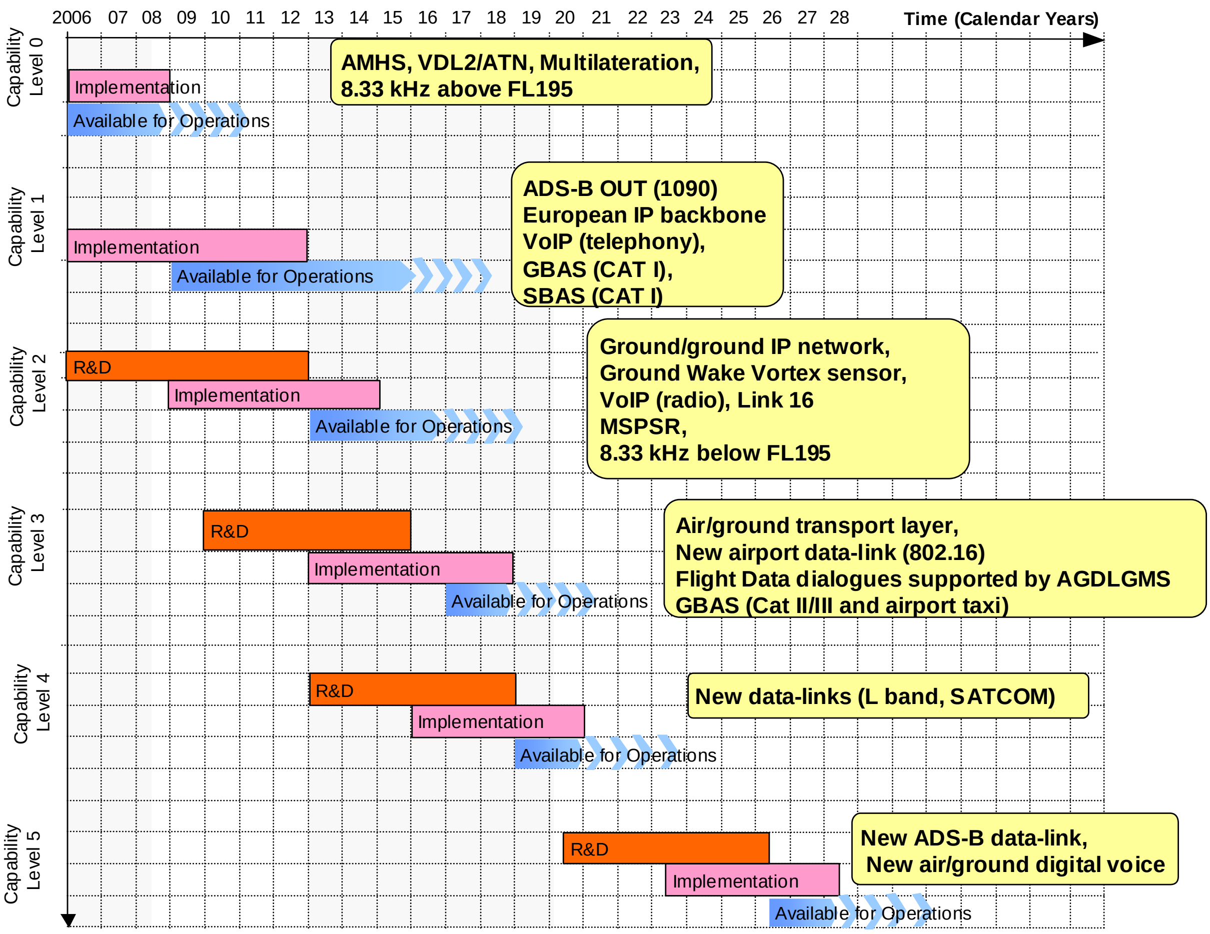

Figure 13 CNS Provider - CNS Systems and Infrastructure roadmap

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 LoC#2 Moving from Airspace to Trajectory Based Operations LoC#3 Collaborative Planning using the NOP
VDL2/ATN: Deploy VDL2 ground stations and ATN routers interfaced with ATC systems.	LoC#1 Information Management LoC#5 Managing Business Trajectories in Real Time 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 LoC#9 Independent

	Cooperative Ground and Airborne Safety Nets 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 LoC#8 New Separation Modes 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 LoC#3 Collaborative Planning using the NOP LoC#5 Managing Business Trajectories in Real Time LoC#6 Collaborative Ground and Airborne Decision Making Tools 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. 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 LoC#3 Collaborative Planning using the NOP LoC#5 Managing Business Trajectories in Real Time LoC#6 Collaborative Ground and

	Airborne Decision Making Tools 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 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.[5]	LoC#5 Managing Business Trajectories in Real Time 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). Develop a performance validation demonstrator to identify the capability and the potential risks of MSPSR technology. Develop and validate solutions that enable existing military Datalink solutions to interoperate with civil Datalinks, while safeguarding military classified data. 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). Develop and validate ground wake vortex detection radar. Develop and validate next generation weather radar.	

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

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. 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. 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. 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. 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. Develop and validate prototype for the development of new Satellite communication system (including specifications to be included in ICAO SARPS and Manual).	

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. Assess potential voice saturation issue to determine if further activities are needed on air ground Digital voice. Develop and validate requirement as necessary.

Regional SWIM Manager – SWIM supervision

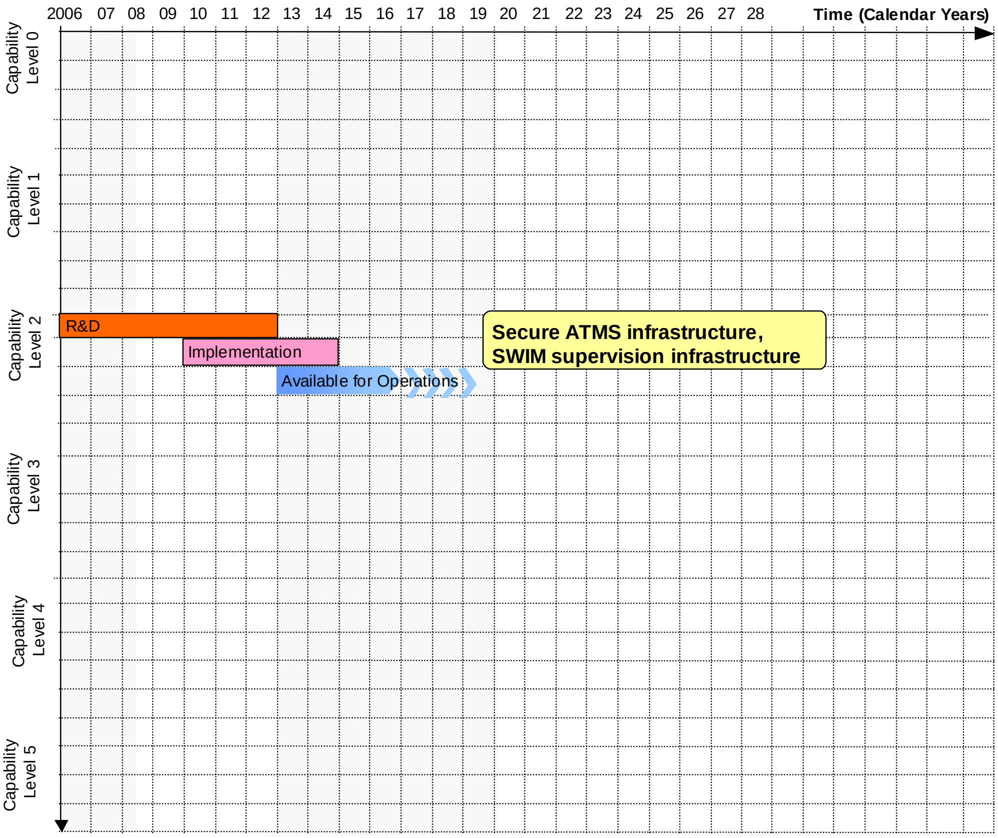

Figure 14 Regional SWIM Supervisor - SWIM supervision

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.

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.

Aeronautical Information Providers - General

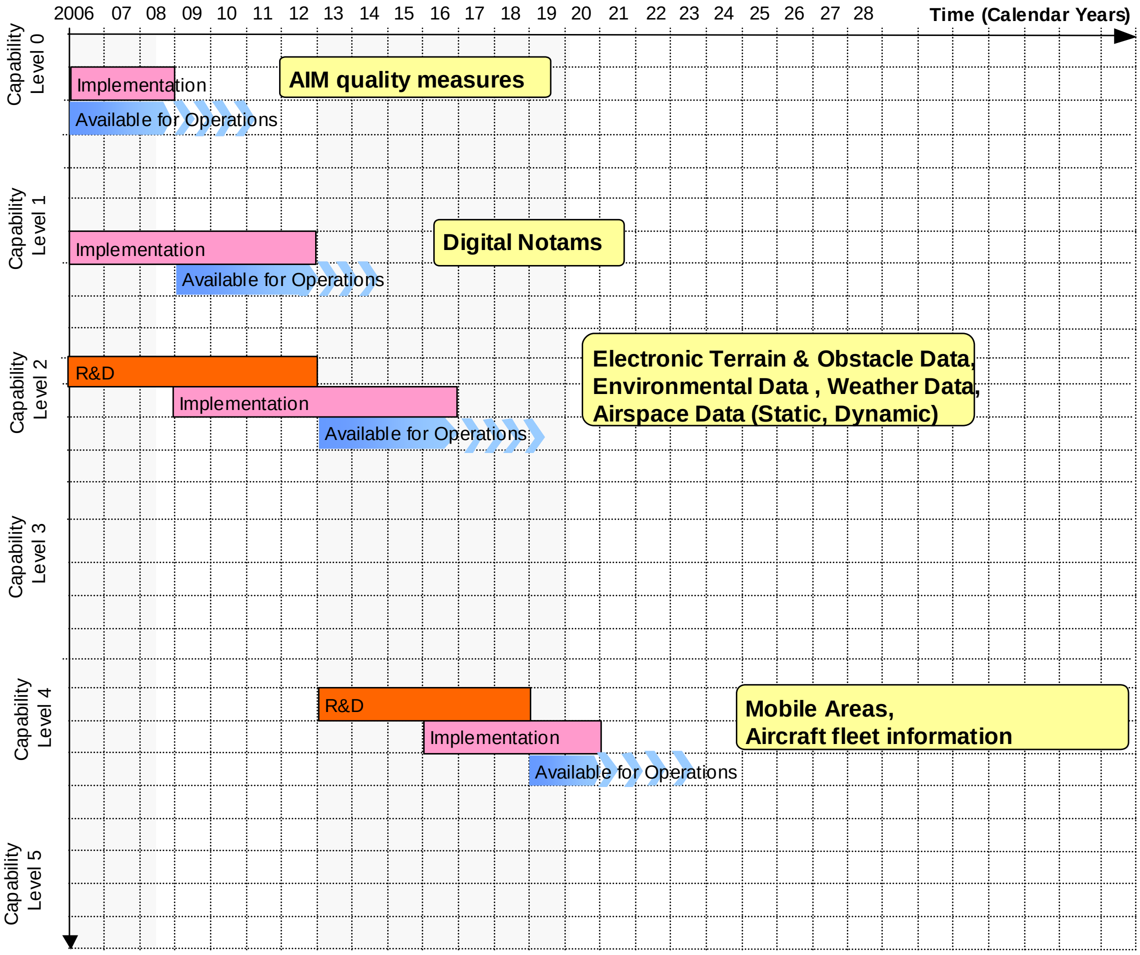

Figure 15 Aeronautical Information Management – AIMS roadmap

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).

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.

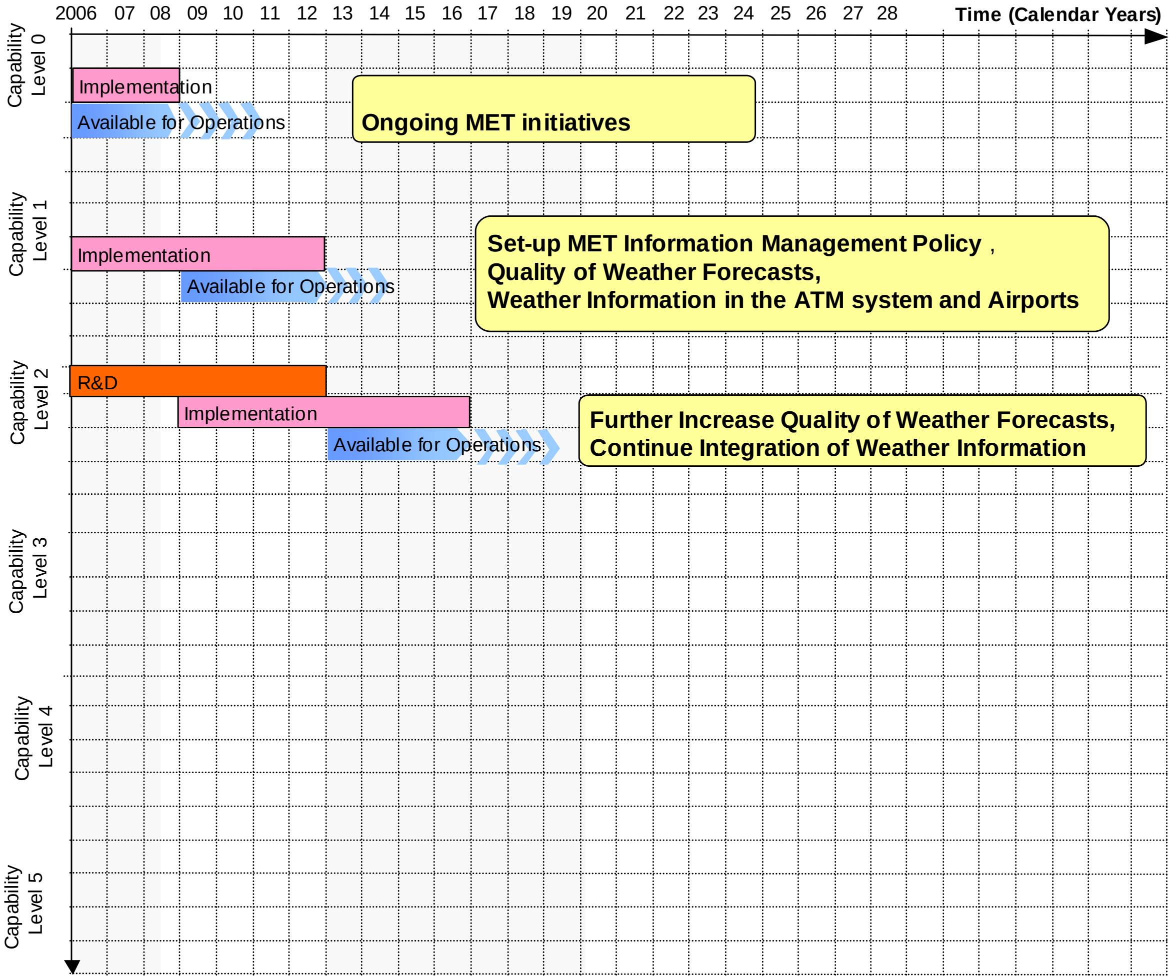

Figure 16 Aeronautical Meteorological Information (MET) Provider - Meteo roadmap

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: Provide probabilistic weather forecasts in support of making greater use of congested/constrained En-Route airspace. Improve the accuracy, timeliness and forecast range of convective weather information (including lightning), turbulence and icing.

Improve accuracy reliability and lead time of visibility/ceiling forecasts and include a measure of uncertainty. Provide high accuracy, high resolution short range wind forecasts. Harmonize use of specialized forecasts for de-icing and snow clearance during winter conditions. Provide forecast of hazardous weather phenomena including low level windshear and temperature inversions (terminal area). Provide weather observations and weather forecasts of wind aloft for approach and departure flight operations and runway selection procedures. 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: Integrate regulated existing and future Met information into the WXXM (weather information exchange model), in conjunction with the ATM Reference model. Include climatology factors into long term planning through conditional climatology methods. Include seasonal forecasts to define optimum routes to be used for schedule and airport/airspace strategic slot planning Use observations and forecasts of volcanic ash and other severe contaminant releases for tracking and display purposes in support of air navigation safety. Integrate meteorological information into Decision Making Support tools in support of network efficiency. Integrate existing convective weather information (including lightning), turbulence and icing in a harmonized way into ATM decision support tools. Adapt existing short term forecasts of visibility/ceiling to specific user requirements and integrate them in CDM processes for Low Visibility Conditions. Deploy Weather Information Systems at Airports 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.. Develop and Validate improvements of forecasts of hazardous weather phenomena required for ATM operations (e.g. low level windshear).

Develop and Validate improvements of Met data to prevent formation of persistent contrails. 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 Increase accuracy and timeliness of meteorological information in support of dynamic modification of airspace sectors. 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. Improve forecast of hazardous weather phenomena including low level windshear and temperature inversions (terminal area). Provide meteorological information to prevent the formation of persistent contrails in serving the environmental impact of air transport.
Continue Integration of Weather Information: Further integrate existing onboard weather sensors (e.g. WMO AMDAR programme) to improve nowcast and forecast capabilities to meet service level 2 & 3 requirements. 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 the quality of weather forecast; the integration of weather information based on the first experiences in use of additional and more accurate weather information.

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.

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 17 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 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.

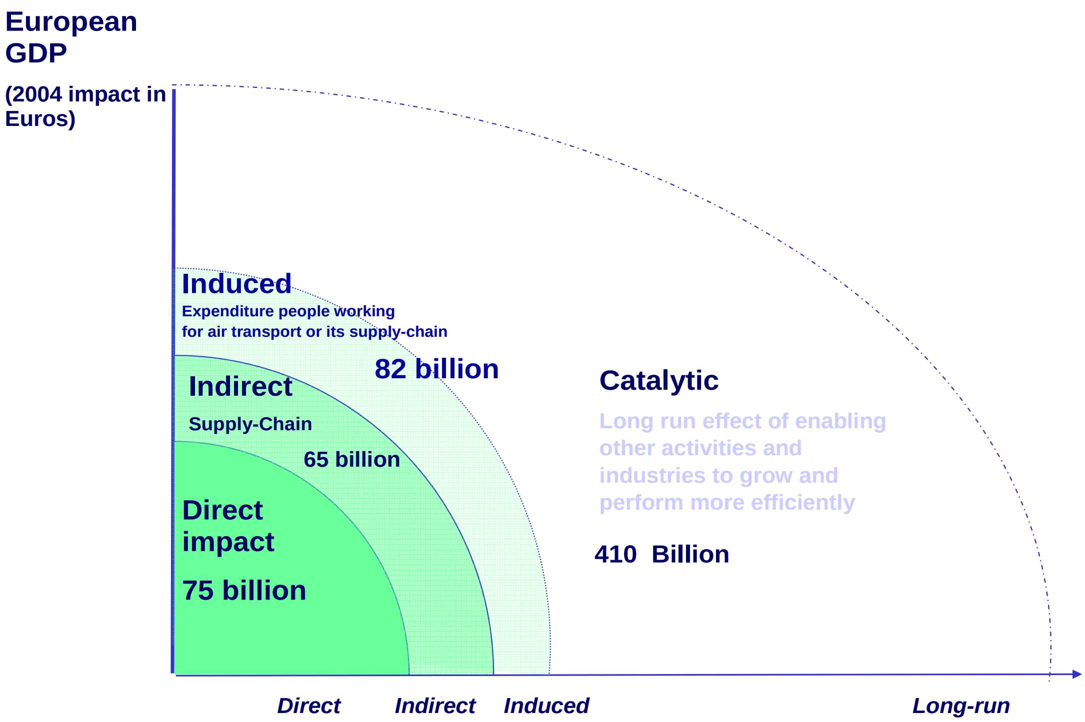

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Figure 17 Aviation contribution to the European GDP in 2004

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 CO_2 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.

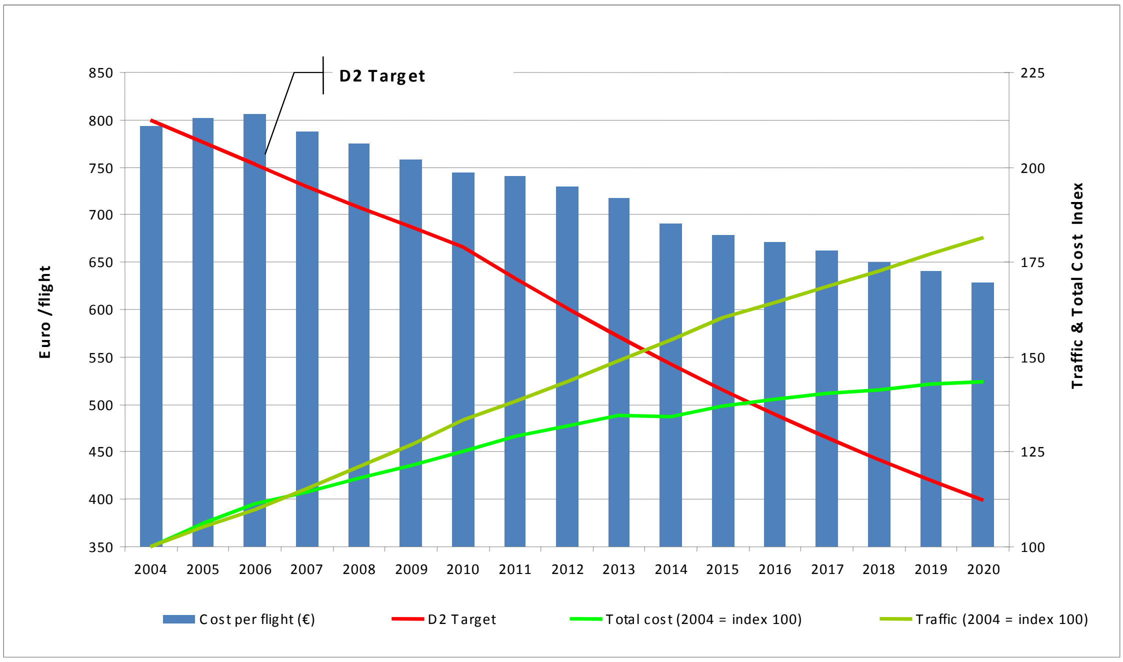
Operational Benefits

Specific targets per KPA have been set for the 2020 ATM Target Concept (see section 0). 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.

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 18 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[6]. 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).

6 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**		→

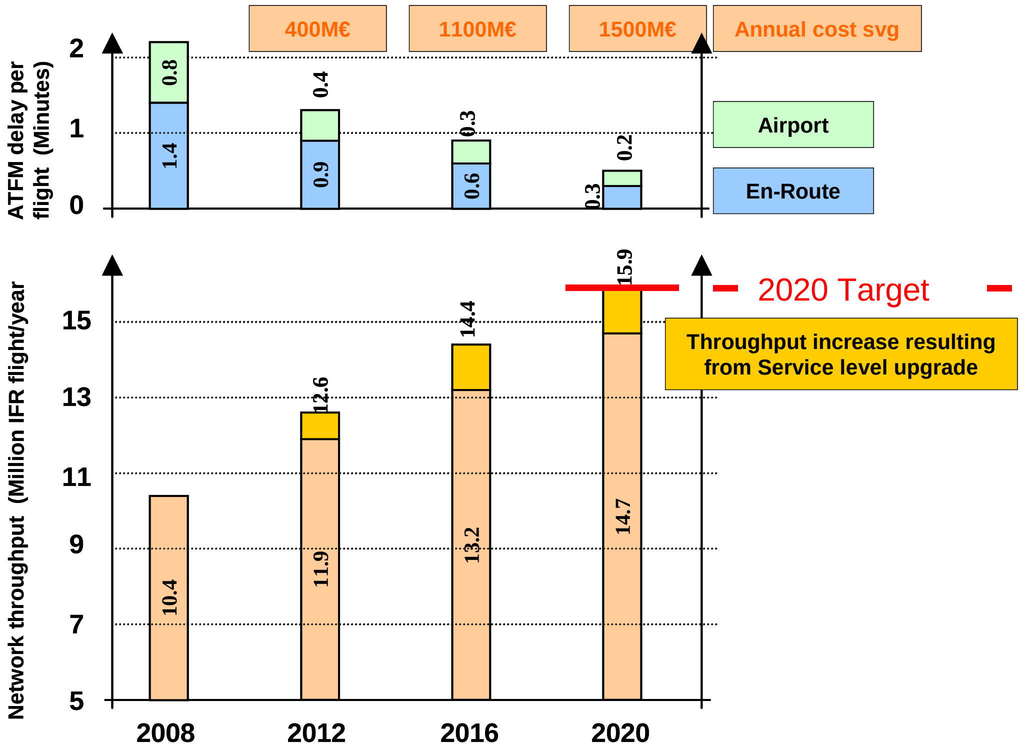
Figure 18 Evolution of the ATM unit costs per flightFigure 18, over the 2008-2020 period, the savings due to direct ATM cost per flight reduction will deliver a benefit of around €8Bn for the commercial airlines.

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 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.

Capacity and Quality of Service



Capacity / Delay		2008	2012	2016	2020
Average ATFM delay per flight	min.	2.2	1.3	0.9	0.5
Total Benefits (Capacity gain & Delay reduction)	€ Bn	← € 9 Bn →			

Figure 19 Network throughput and delay development from 2008 to 2020

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[7] 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.

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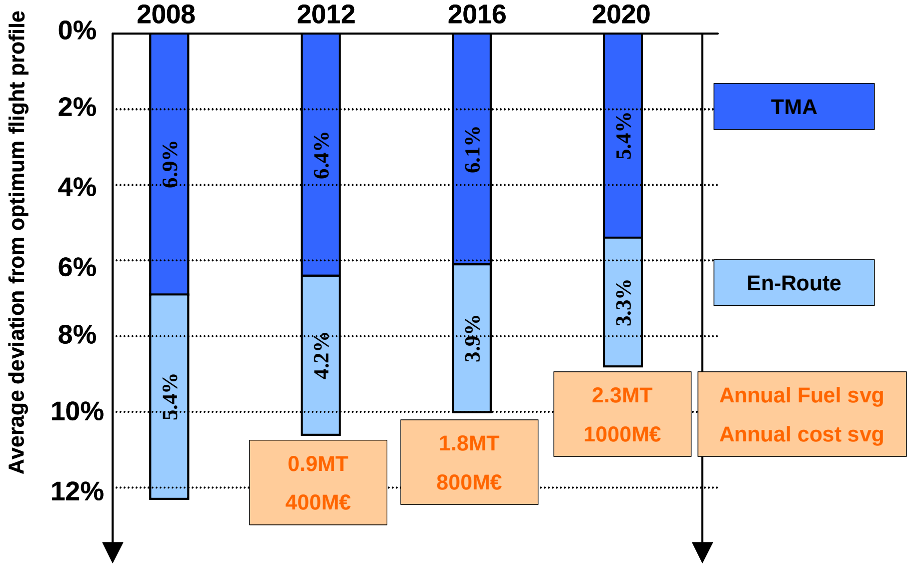
[7] In D4, the average ATFM delay was estimated at 1.2 minute in 2020 (0.5 En-Route and 0.7 Airport). This estimation has been updated in D5 since the inputs used during the D4 for Airport Capacity improvement and Airspace Capacity in medium density airspace were not correct. This estimated average ATFM delay does not include weather or special events related delays.

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 **Fehler! Verweisquelle konnte nicht gefunden werden.**. 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 19, 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[8].



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 →			

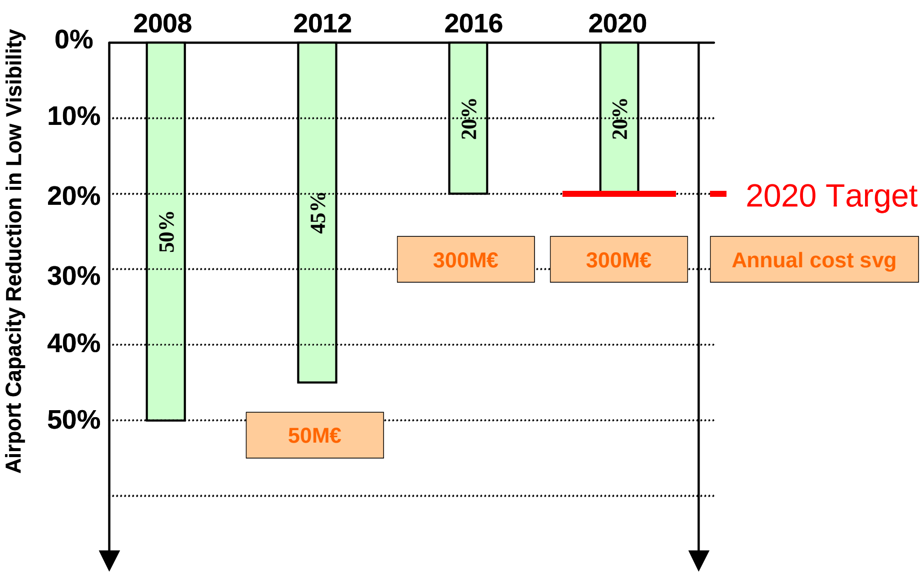
Figure 20 Fuel efficiency savings from 2008 to 2020

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 20 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.

8 SESAR benefit monetised based on CBA standard values: Additional flight=€700, one minute of delay=€35, Passenger value time = €40 (per minute of delay)

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 0).



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 21 Low visibility savings from 2008 to 2020

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 21).

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.

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 1.

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 1 Initial benefits for specific KPAs

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.

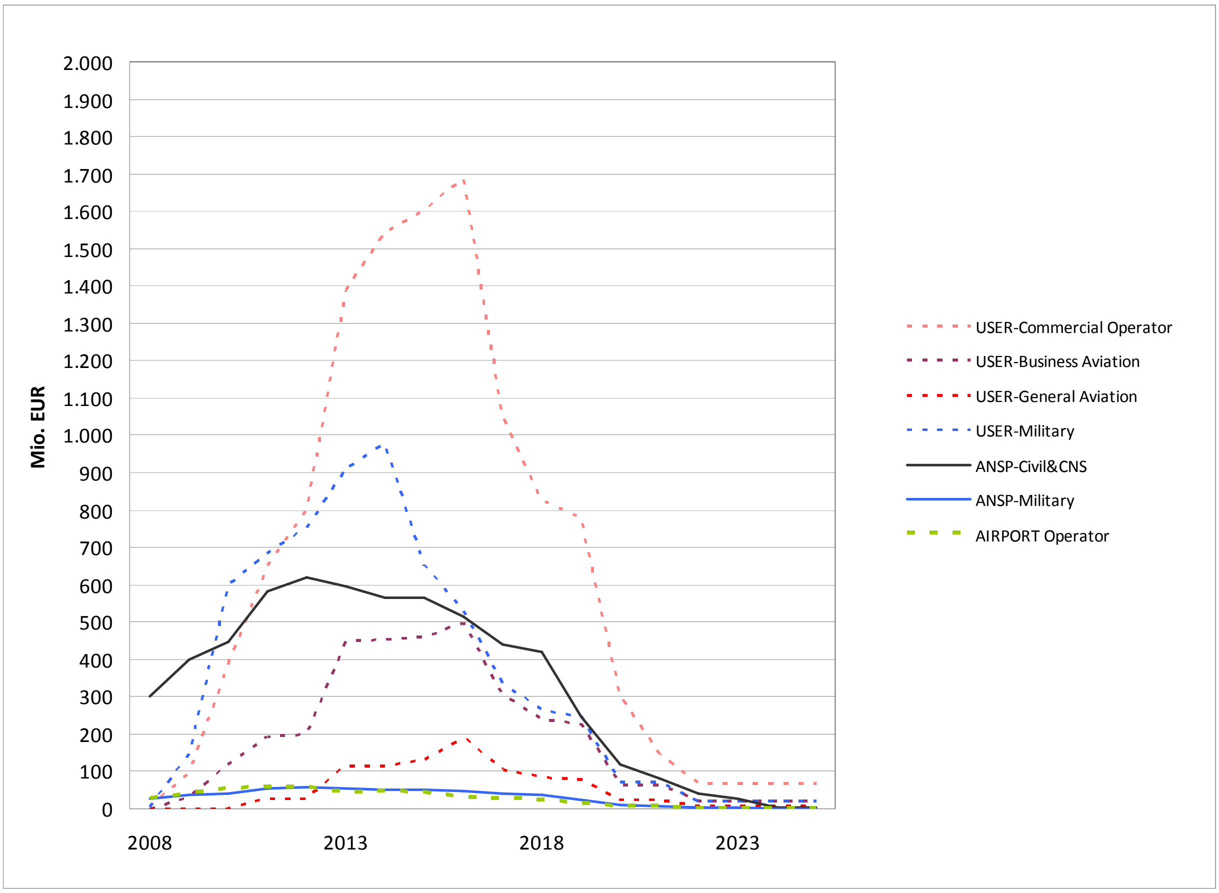
Coordinated procurement is assumed to a certain extent in the current cost assessment. An uncoordinated approach will create the risk of an increase of the investment by 5-15%. This could be facilitated through a coordination entity, which also could take the benefit arising from the deployment of parallel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

Stakeholders investments

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 22 and Table 2 provide a breakdown of the total investments and the investments over time per stakeholder.



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

Descrip.		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

Figure 22 SESAR Investment per stakeholder per time to achieve ATM capability level 3

Table 2 Stakeholders SESAR Investment overview

(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.

Users costs

Users costs have been computed (see Table 3) 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	GA IFR	GA VFR	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**

Table 3 Users number of aircraft, cost per aircraft and total cost

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

Figure 23 and Figure 24 show a split of the avionics costs to achieve the required aircraft CNS performance.

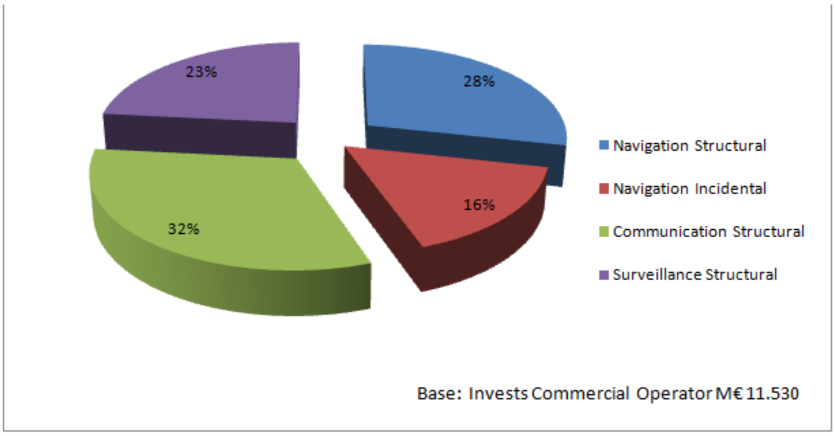


Figure 23 Division of commercial operators airborne equipage costs in CNS functionality

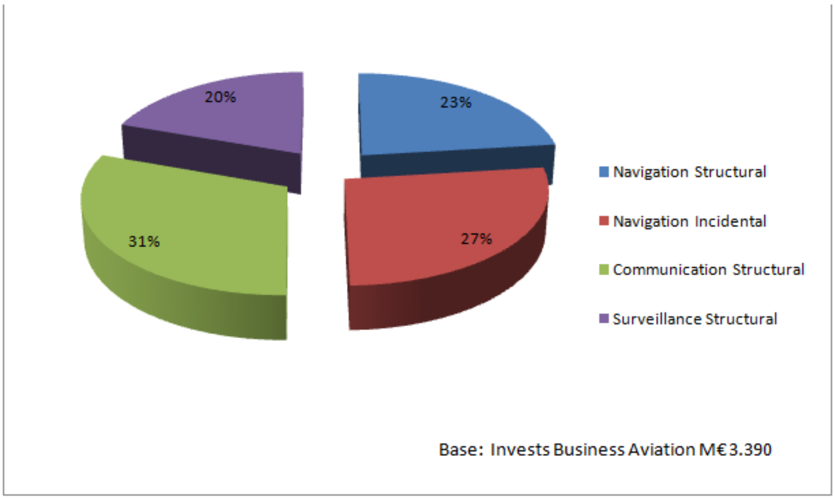


Figure 24 Division of business aviation airborne equipage costs in CNS functionality

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 4 and Table 5 respectively.

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 4 Users additional training costs

Description		Commercial	BA	GA	Military	Total One-off (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

Table 5 Users operational ground costs

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

ANS Provider

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

ANS Provider expenditures/costs (Table 2) 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 25 provides a division of the costs per major ATM system.

Table 6 shows the costs of architecture and CNS systems per capability level.

Table 6 ANS Provider Civil & CNS 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**

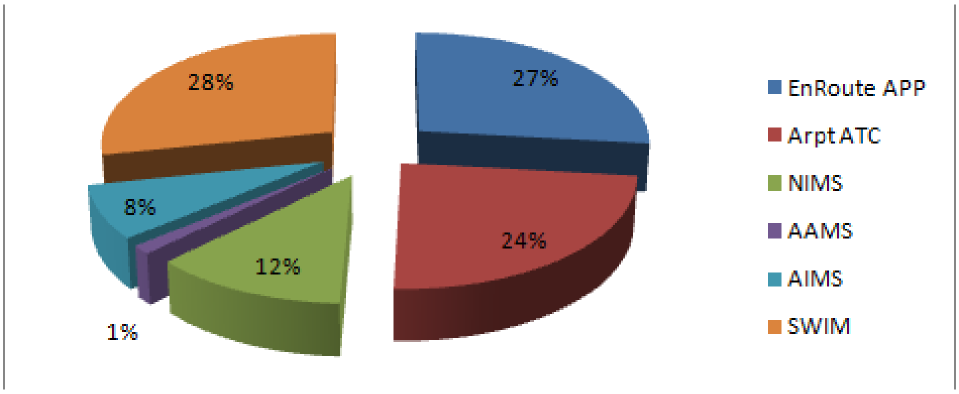


Figure 25 ANS Provider Civil - Architecture Investments

ANS Provider Military

Table 7 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 deploy ment	140	140	0
	2+3		240	240	0
Subtotal			**380**	**380**	**0**
CNS Cap.Level	1	see deploy ment	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 7 ANS Provider Military investment

Airport Operator

Table 8 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[9] 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 8 Airport Operator investment

9 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.

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.

Cost Benefit Analysis (CBA)

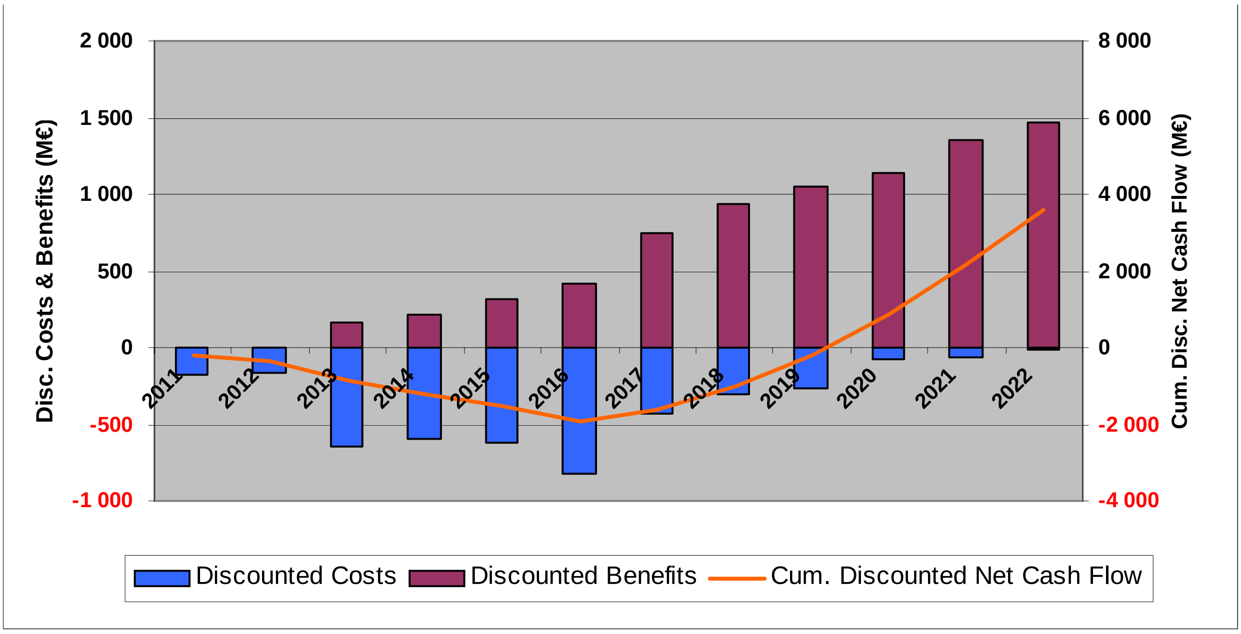


Figure 26 Initial CBA analysis for commercial airlines

Figure 26 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 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.

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.

Funding and Financing Aspects of the ATM system deployment

Funding and financing of the ATM system deployment

The ATM Sources of Financing and Funding are represented in Figure 27.

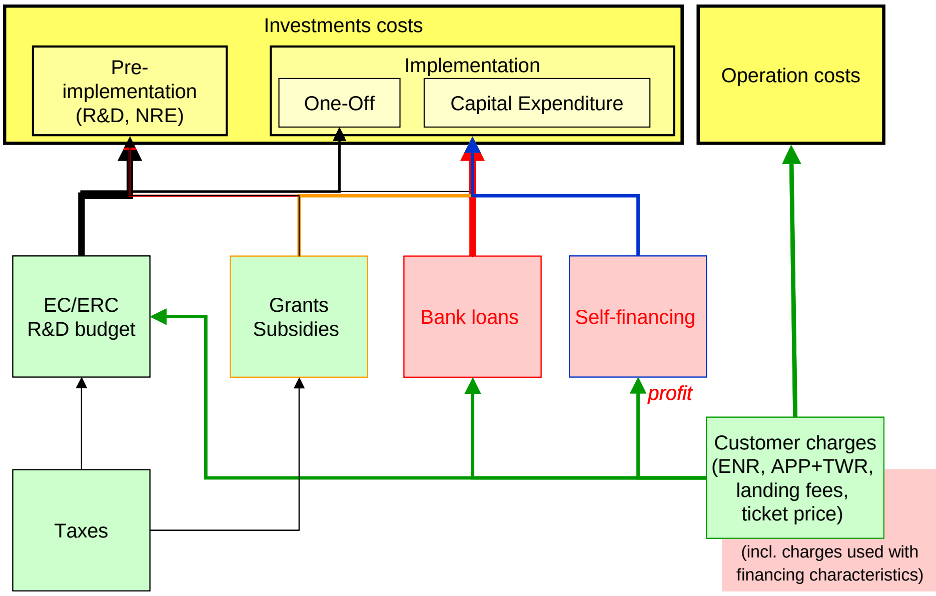


Figure 27 ATM sources of Financing and Funding

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).

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.

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 28.

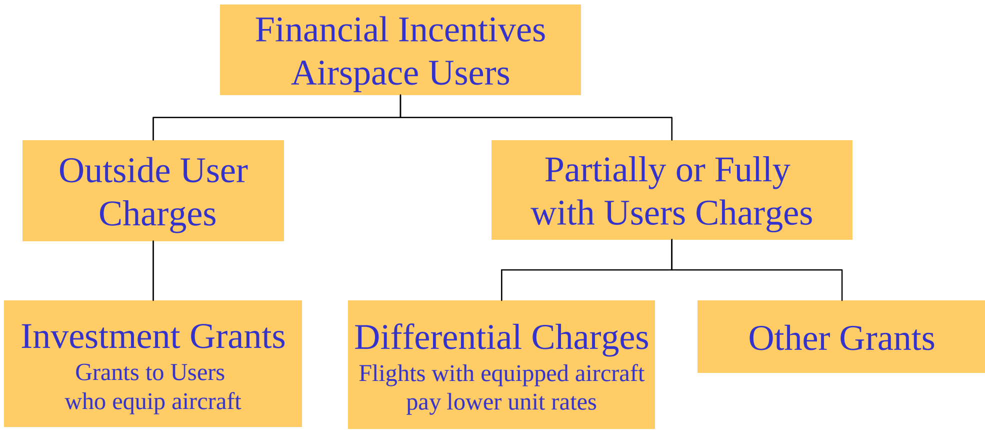


Figure 28 Types of Financial Incentives for Airspace Users

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.

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.

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 29 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.

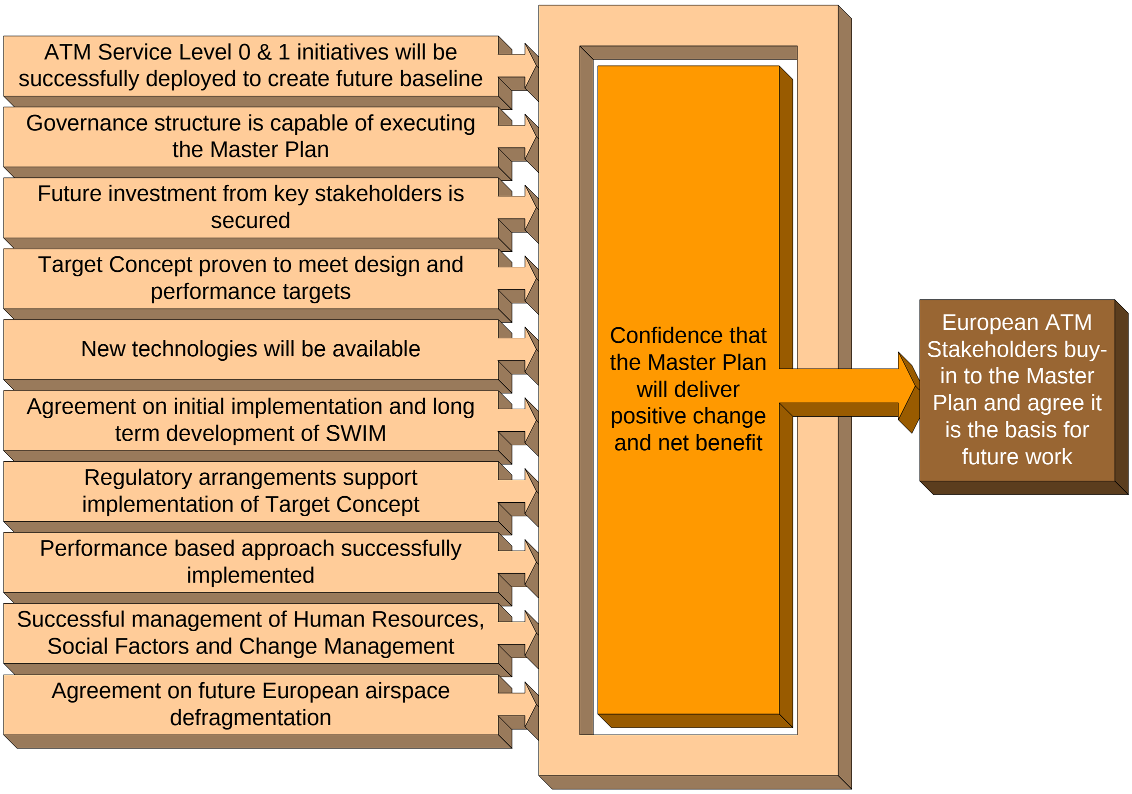


Figure 29 Factors Influencing Stakeholder Buy-in

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.

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 30, 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.

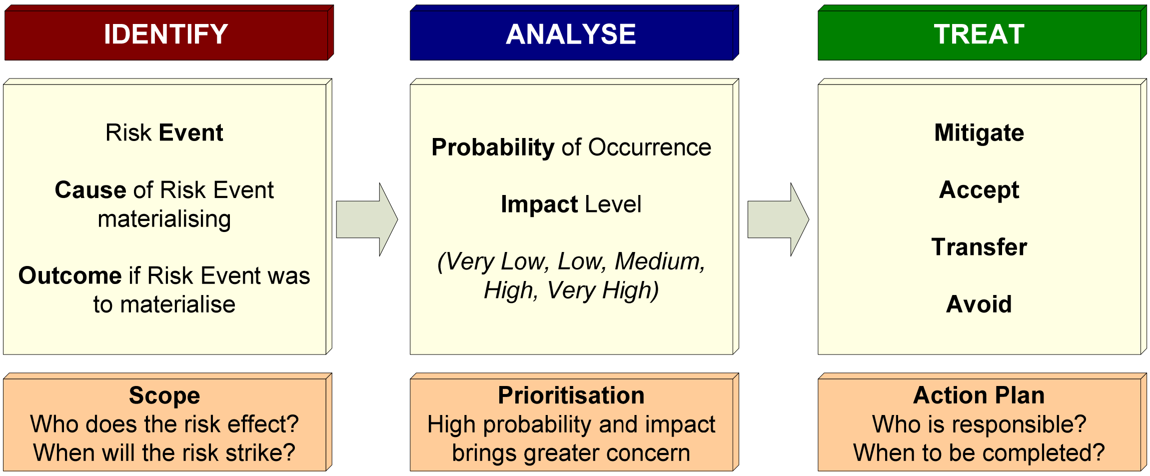


Figure 30 Risk Management Methodology

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.

High Priority Risks

Figure 31 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]).

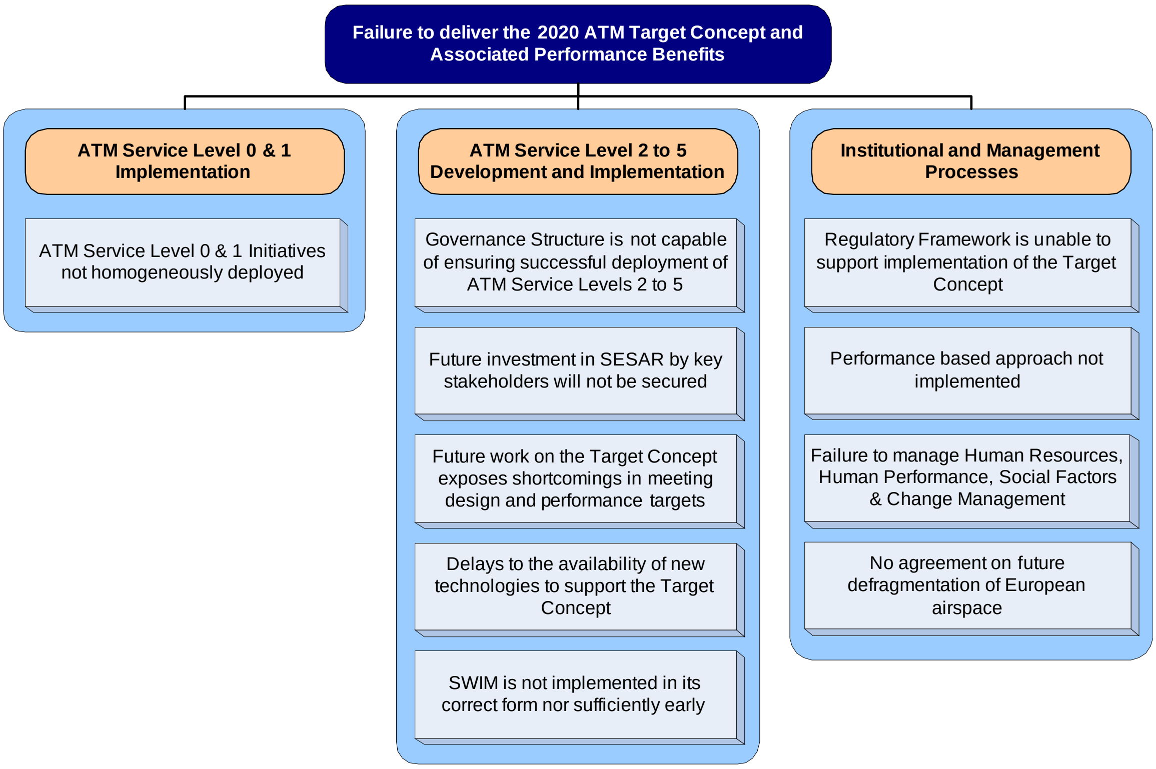


Figure 31 Highest Priority Risks

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.

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.

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 by 2020.

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 9, and mitigation actions proposed in Table 10.

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 Lack of appropriate governance and leadership for the implementation period 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 Potential duplication of efforts across Europe 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 9 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 10 Mitigation Actions

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.

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 11, and mitigation actions proposed in Table 12.

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 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 11 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 12 Mitigation Actions

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 13, and mitigation actions proposed in Table 14.

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 Expected benefits from ATM Service Level 1 implementation are not produced High sensitivity in benefit delivery pushes break even point fatally to the right Overall costs exceed the available budget Affected stakeholders are not properly involved in decision making during the Development Phase
Outcome
Insufficient financial resources and investment SESAR fails and return to business as usual 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 13 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 14 Mitigation Actions

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 15, and mitigation actions proposed in Table 16.

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 Concept does not focus sufficiently on congested areas of Europe Concept does not deliver improved performance in adverse weather conditions

Lack of integration of the Performance based approach into Concept development
Outcome
Future European ATM system will not deliver required performance improvements 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 15 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 16 Mitigation Actions

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 17, and mitigation actions proposed in Table 18.

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 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 A lack of prioritisation of the R&D activities leading to spending money on projects that do not directly contribute to improved ATM performance The technology available in the required timeframe does not meet the expected ATM performance requirements 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 17 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 18 Mitigation Actions

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 19, and mitigation actions proposed in Table 20.

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 Data networks are not available to support information sharing amongst all partners Ground and airborne systems are not deployed so as to complete the SWIM Network 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 Aeronautical information with extended scope is not available to ground and airborne systems 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 19 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 20 Mitigation Actions

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.

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 21, and mitigation actions proposed in Table 22.

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) 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 Potential for regulatory fragmentation leading to increased costs for providing assurance 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 21 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 22 Mitigation Actions

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 23, and mitigation actions proposed in Table 24.

Risk Event
Failure to implement the SESAR Performance Based Approach
Cause
No appropriate process to implement the SESAR Performance Framework Stakeholders do not commit to ATM Performance Partnership

No appropriate enforcement mechanisms to support/accelerate implementation Lack of convergence to a common approach by organisations who have notably their own local performance approaches 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 At the highest level, the citizens of the EU will have constrained choice and increased delays 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 23 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 24 Mitigation Actions

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 25, and mitigation actions proposed in Table 26.

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 Lack of verified and competent Human Resources to support operations in increasing traffic levels, training requirements, and user involvement in design and validation processes 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 25 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 26 Mitigation Actions

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 27, and mitigation actions proposed in Table 28.

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 Infrastructure changes to enable the creation of FABs are not carried out Social changes necessary to work the FABs cannot be agreed
Outcome
Delayed delivery of performance benefits that are conditional upon FAB implementation. 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 27 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 28 Mitigation Actions

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:**

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;

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;

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.);

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.

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.

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.);

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.

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)

List of Abbreviations and Terminology

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

Abbreviation	Explanation
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

Abbreviation	Explanation
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
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

Abbreviation	Explanation
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

Abbreviation	Explanation
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
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

Abbreviation	Explanation
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

Abbreviation	Explanation
MONA	Monitoring Aids
MOP	Milestone Objective Plan
MOPS	Minimum Operational Performance Specifications
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

Abbreviation	Explanation
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

Abbreviation	Explanation
SV/SVS	Synthetic Vision/ SV System
SWIM	System Wide Information Management
TCAS	Traffic Collision Avoidance System
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

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)

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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 CO_2 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)[10]. **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 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

10 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.

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

The cost for the equipage of an average large commercial aircraft to implement IP2 capabilities is estimated to be around €1 Million.

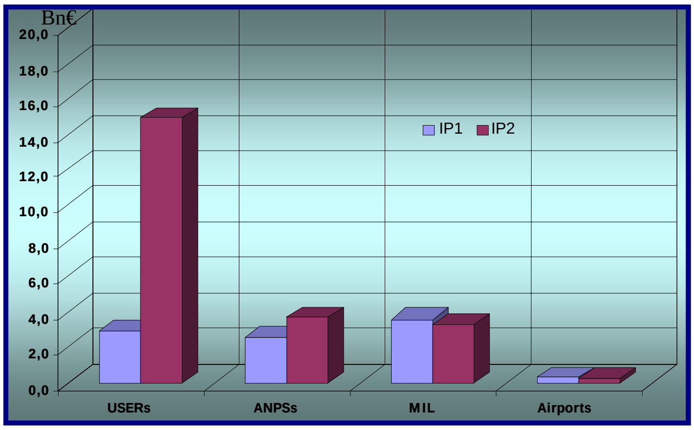

Figure 32 Stakeholder Investment Costs

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:

Mandates backed by incentives and disincentives are required for ensuring synchronisation;

Grants and other incentives are particularly required for meeting the pre-financing requirements during the period of 2013 to 2017;

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;

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).

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**.

Participating Stakeholder Groups

For the purpose of describing Stakeholder involvement in Master Planning the Stakeholders have been categorised as shown in Table 29 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 29 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 (comprises Legacy Airlines, Low Fare Airlines, Regional Airlines)
	USER IFR Capable GA (comprises Business Aviation (BA), High-End GA, VLJ Operators, IFR Helicopter Operators, factory demonstrations and flight trials etc.)
	USER VFR Only GA (comprises Low-End GA)
	USER Military and State Aviation (comprises GAT and OAT)
	USER UAV/UAS Operators (comprises civil and military UAV/UAS operators)
AIRPORT Operator	AIRPORT Operator Civil
	AIRPORT Operator Military

Stakeholder Category	Stakeholder Role
ANS Provider	ANS Provider Civil (comprises civil Airport, TMA and Enroute ANS Providers)
	ANS Provider Military (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 29 Stakeholder Categorisation

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 30 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. **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. **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. **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). Notes: No best-in-class targets have been defined for complex airports (3 or more runways). These airports will have to be looked at individually. 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: **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); **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); **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). For the military airspace users who conduct training activities: **Reduce the economic impact of transit**: measured as the total cost of transit from base to training area and back; **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.
QoS: Flexibility	For VFR flights, the performance objectives and targets for 2020 are: **Improved accommodation of VFR-IFR change requests**: 98% of such requests should be accommodated without delay penalties. For unscheduled IFR flights (users not providing early notification of flight intentions), the performance objectives and targets for 2020 are: **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). 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: **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); **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). For all airspace users, there are additional objectives related to flexibility: Keep the number of flexibility requests (see above) as low as possible (in relation to the total volume of traffic);

	Inform the ATM System of the flexibility requests (see above) as early as possible. 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: Improve the ability to increase/decrease the amount of airspace segregation as required; Maximise adherence of military training activities to optimum airspace dimension; Improve the utilisation of segregated airspace by military training activities; **Improve the actual airspace usage** by military users compared with that booked by planners; Increase the amount of time that training in non-segregated airspace is possible; Improve the release of airspace by military users.
QoS: Predictability	At European annual level, the predictability objectives and targets for 2020 are: **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; **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); **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); **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); **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); **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); **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. 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.
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; **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[11], 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: **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,

[11] 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 CO2 emissions through drastic reduction of fuel consumption; 80% reduction of NOx emissions (Nitrogen Oxides); 50% reduction of external noise; A green product life cycle: design, manufacturing, maintenance and disposal / recycling. (source: www.cleansky.eu)

	thereby enabling a 10% reduction of CO_2 emissions per flight; **Improve the management of noise emissions and their impacts**: to ensure that these are minimised for each flight to the greatest extent possible; **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; **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: 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); **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). Improve equity: **For priority management**, ensure that **more options** will be available than just the 'first come first serve' rule; 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: The efficiency of business trajectories for intra-European and intercontinental flights; Airspace and airport related access for intra-European and intercontinental flights; Airspace and airport related equity for intra-European and intercontinental flights.

Participation	Improve participation by the Stakeholders / ATM Community: During planning, development, deployment, operation and evaluation/improvement of the ATM system For all performance areas: access and equity, capacity, cost effectiveness, efficiency, environment, flexibility, interoperability, predictability, safety, security By involvement of all ATM community segments While respecting all applicable rules, regulations and legislation Choose the most appropriate (combination of) method(s) and level of involvement (depending on the circumstances): informing the community, obtaining feedback and advice from the community, collaborative decision making (CDM), consensus building. 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 30 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 0.

Relationship between SWIM and ATM Performance

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.

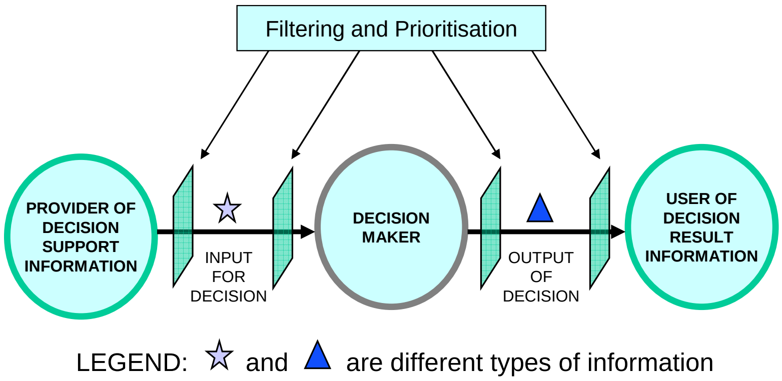

Figure 33 Interaction between Information Providers, Decision Makers, and Information Users

As is illustrated in Figure 33, the performance of ATM depends on six factors:

Existence of airborne and ground-based suppliers (systems and service providers) for the various types of ATM decision support information;

Availability, quality and timeliness of the provided decision support information (quality includes integrity, accuracy, completeness, legibility, trustworthiness etc.);

Ability of airborne and ground-based ATM decision makers to receive, absorb and use available information;

Quality and timeliness of the airborne and ground-based decision making itself;

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);

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 31, which contrasts the information management situation before and after deployment of SWIM.

ATM information management prior to SWIM	Target situation after SWIM deployment

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

ATM information management prior to SWIM	Target situation after SWIM deployment
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 31 Information Management before and after SWIM deployment