THE **SESAR** INITIATIVE

Research paves the way for the Single European Sky

Directorate-General for Energy and Transport

EUROPEAN COMMISSION

CONTENTS

This publication was produced by the EXTR@Web consortium on behalf of DG Energy and Transport. The information in this document has been collected by partners in the project on the basis of material provided by DG TREN, Eurocontrol and other sources.

We would like to thank Eurocontrol for contributing to the review of the manuscript.

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Photos courtesy of Airbus, Air Traffic Alliance, DFS Deutsche Flugsicherung GmbH, Eumetsat, Eurocontrol, MFF project, Wolfgang Helmreich

Printed in Belgium

FOREWORD

SESAR, the implementation programme for the Single European Sky (SES), is aimed at channelling, co-ordinating and guiding efforts among the aviation industry, the European Commission and Eurocontrol with a view to establish a harmonised European air traffic management network by the year 2020 with the necessary performance to meet projected traffic growth.

The SESAR initiative complements SES regulatory and legislative frameworks by paving the way for the implementation of technical, operational and organisational changes and improvements.

The initiative, which aims to reduce fragmentation of European ATM systems through synchronising and integrating plans and actions, will see two major steps to ensure that organisational and regulatory SES concepts as well as important advances in technology, research and validation are adequately addressed:

- A two-year definition phase that is tasked with devising an Air Traffic Management (ATM) Master Plan defining common goals and a vision for the development of the European air traffic control infrastructure. It is scheduled to be finished by early 2008. The SESAR definition phase is jointly co-funded through the Trans European Network Transport (TEN-T) scheme by the European Commission and Eurocontrol. The total budget of approximately 60 million euros will be funded by a 30 million euro contribution from TEN-T, together with the same amount from Eurocontrol, roughly equally spread between cash, direct effort contribution to the work contracted to industry and own complementary activities.
- An industry-led development and implementation phase, which will be based upon the results of the definition phase, and will establish the next generation of air traffic control systems, synchronise their deployment and implementation. This phase will span from 2007 to at least 2020, and will be managed under a new governance scheme, which will unite the forces of different stakeholders and institutions. This phase will be itself divided into three consistent technological and functional packages, which will be implemented consecutively at a European level.

In essence, all activities ranging from research and technical development to operational deployment are covered in SESAR by taking into account the conceptual, industrial, institutional, legal and regulatory perspectives.

A European vision with a global perspective

Many developments under the Single European Sky scheme will involve collaboration with major undertakings in other key regions of commercial aviation such as the United States of America, Australia and China.

The US counterpart of the Single European Sky – known as the Next Generation Air Transportation System (NGATS) – is currently devising its own framework for the definition and development of advanced ATM architectures with the aim to ensure interoperability at a wider scale. In this context, the European Commission and the US Federal Aviation Administration (FAA) intend to pursue close co-ordination of their two respective initiatives aimed at preparing air transport systems for tomorrow's challenges. On the industry side, several major US companies such as Boeing[1], Rockwell Collins and Honeywell will be associated to SESAR's definition phase.

At the first EU-China aviation summit[2] the intention was confirmed to engage "[…] in negotiations in the coming months with a view to conclude an agreement relating to technical co-operation in civil aviation including matters such as safety, security and air traffic management and the related SESAME[3] programme."

An independent study[4] has estimated the long-term economic benefits of the SESAR development and implementation phase at some 60 billion euros with the potential to trigger up to 200,000 new jobs in the aviation sector across Europe.

This brochure covers ongoing activities of SESAR's definition phase while also looking at the implications of current undertakings such as the forthcoming ATM master plan, recent research findings and industrial efforts to meet the targets of the Single European Sky.

1. 'Global Interoperability: Prerequisite for future growth in air transport'; Position paper prepared by Boeing and the Air Traffic Alliance (a grouping of EADS, Airbus and Thales); Maastricht, February 2005
2. Joint declaration on EU-China co-operation in civil aviation; EU-China aviation summit, Beijing 29 June - 01 July 2005
3. SESAME was the name of the SESAR initiative until autumn 2005.
4. 'SESAME CBA and governance – Assessment of options, benefits and associated costs of the SESAME programme for the definition of the future air traffic management system'; Steer Davies Gleave, London, draft final report, May 2005

1 THE SINGLE EUROPEAN SKY FRAMEWORK

Though the last decade of the twentieth century has seen considerable improvements in ATM systems, aircraft safety systems, airports' technical equipment and organisational structures thanks to efforts by Eurocontrol and the European Commission as well as those by individual actors in the aviation industry, the desired breakthrough towards a highly interoperable, safe and cost-efficient air traffic regime remained pending. This is where the EC's transport commissioner Ms de Palacio took initiative in 1999 and launched an ambitious scheme under the title Single European Sky.

Besides the obvious need to address persistently robust air traffic growth with its related implications on capacity, safety, the environment and costs, the SES idea aimed to set the legislative and regulatory foundations for future actions, while at the same time gathering together all relevant stakeholders in a field historically suffering from fragmentation of technology, national rather than operational considerations and an unacceptable level of parallel developments.

Four linked European Commission regulations define the scope of activities needed to set up the SES:

- **The framework regulation**[5] establishes a harmonised institutional and regulatory framework for the creation of the SES, requiring Member States to nominate 'National Supervisory Authorities' (NSAs), independent of service providers. It creates a 'Single Sky Committee' and defines how implementing rules are to be developed through mandates to Eurocontrol.
- **The service provision regulation**[6] establishes requirements for the safe and efficient provision of these services in the Community that address, among other things, safety, quality, security and accounting systems. It sets out the NSAs' tasks and requires the transposition of Eurocontrol Safety Regulatory Requirements (ESARRs) into Community law. It introduces a certification mechanism for Air Navigation Services Providers (ANSPs) and the means of monitoring compliance, together with requirements for greater transparency and a new charging scheme for air navigation services.
- **The airspace regulation**[7] establishes the conditions and requirements for creating transnational functional airspace blocks (FABs), to ensure the most efficient approach to airspace organisation. It also encourages the 'progressive harmonisation' of airspace classification, based on the simplified approach defined in the Eurocontrol airspace strategy.
- **The interoperability regulation**[8] aims at achieving the interoperability of the European Air Traffic Management Network (EATMN), by defining essential requirements for it, and by expediting the introduction of new operational concepts and technology. The regulation will be supported by implementing rules, standards and Community specifications. Compliance with the regulation will be assured by manufacturers 'declarations of conformity', monitored by notified bodies.

5. Regulation (EC) No 549/2004
6. Regulation (EC) No 550/2004
7. Regulation (EC) No 551/2004
8. Regulation (EC) No 552/2004

Originally conceived in 1999, key themes of the Single European Sky (SES) initiative – legally adopted in March 2004 – include the achievement of:

- The **flexible use of airspace** through civil-military co-ordination and improvements to air traffic flow management;
- **an airspace design** building on the harmonisation of airspace classification and design, and the definition of a single European upper information region;
- **functional airspace blocks** key to rationalisation and consolidation of service provision;
- an overall ATM system of **reinforced and improved safety**;
- a **common charging scheme** for Air Navigation Services (ANS) including rules for both en-route and terminal charges, support for functional airspace blocks, incentive mechanisms, and organised reviews of charges; and
- **interoperability** through a new approach to standards building on high-level essential requirements, detailed through binding implementing rules or through voluntary industry standards, and implementing rules enabling the introduction of new equipment and procedures synchronised between States, service providers and users.

A FAB initiative: towards a united UK-Irish airspace

A recent study[9] by independent consultants suggests establishing a single Functional Airspace Block (FAB) in UK and Irish airspace by the year 2008. The Anglo-Irish reorganisation of airspace and related air traffic control tasks could help reduce costs and improve quality of service according to stakeholders consulted.

The report, commissioned by the UK's National Air Traffic Services and the Irish Aviation Authority, recommends expanding the scope of FABs to the entire airspace above ground operations rather than following a division into lower and upper airspace with a somewhat arbitrary separation at 28,500 ft or roughly 8,700 m (FL 285). On the basis of this study, the UK and Ireland applied for, and received, funding to further develop the establishment of this FAB under the Trans-European Networks (TEN-T) programme.

Implementation of SES defined regulations and actions is under way, with the EC having issued several mandates to Eurocontrol that resulted in proposed implementation rules, such as:

- The Flexible Use of Airspace (FUA) which has already been implemented by most participating States;
- targeted rules on airspace design;
- the definition of criteria for the establishment of cross-border Functional Airspace Blocks (FABs) which have already been subject of active discussions in some cases; and
- a common air navigation charging scheme currently being discussed among Air Navigation Service Providers (ANSPs) and national authorities.

The SESAR initiative aims to reduce fragmentation, co-ordinate and integrate plans and actions needed to fulfil the promise of a single harmonised European airspace. The European Commission is supported and advised in these actions by two important groups established in the frame of the SES regulation, namely:

- The Single Sky Committee comprised of Member States; and
- the Industry Consultation Body on which the ATM industry and other professional stakeholders are represented.

After its formal kick-off in November 2005, the SESAR definition phase study – undertaken by a 30-partner consortium led by Air Traffic Alliance (ATA) – is now concentrating on preparing six key deliverables intended to:

- Analyse the overall air transport framework;
- define performance objectives for the future ATM system;
- specify target concepts that will help meet these performance objectives;
- plan the deployment and implementation sequence of relevant solutions;
- draft a European ATM Masterplan summarizing the recommendations of the air transport industry; and
- define the concrete work programme for the first phase of implementation.

9. 'Study into the issues and options associated with establishing a functional airspace block in UK and Irish airspace'; Solar Alliance, London, final report, June 2005

2 AIR TRANSPORT RESEARCH NEEDS

Air traffic growth has been steady over the past decades with a forecast annual increase in flights of up to 3.4% per annum through to the year 2025, meaning that air traffic demand is likely to more than double by that date. At the same time ATM equipment in use is becoming increasingly obsolete, suffers from poor technical and operational interoperability, and is characterised by considerable deviations in technical standards. The ATM industry has traditionally been highly fragmented, driven by national interests and with a low level of co-operation.

The consequences of those principal constraints are:

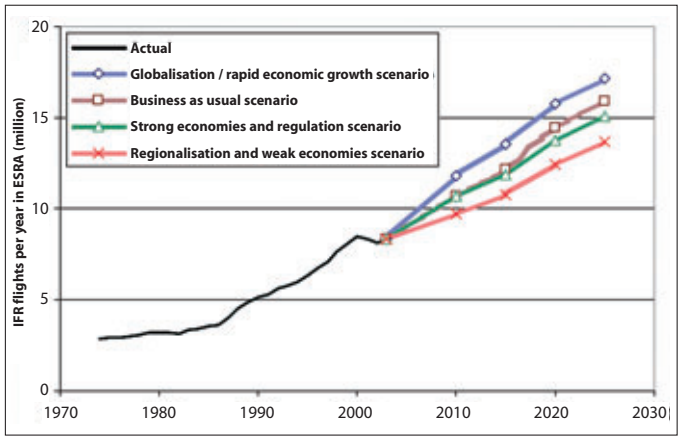
- Emerging bottlenecks at major European airports due to lack of space, runway and taxiway limitations, outdated ground control equipment;
- the inefficient use of airspace due to conventional ATC procedures and supporting systems, as well as legacy structures of upper and lower airspace which are no longer able to generate enough extra capacity (while even the most up-to-date equipment cannot guarantee sufficient capacity);
- safety and security concerns at airports as well as during flight operations;
- rising environmental impacts and costs of air transport; and
- an overall poor cost-efficiency ratio in air traffic operations.

Though existing systems generally are able to cope with current air traffic – the post September 2001 downturn in aviation contributed favourably here – a capacity and safety 'ceiling' could soon be reached. Hence there is the need to:

- Come up with new operational structures and concepts, and
- heavily invest in new technologies to support them (ATC, airports, route planning, safety and security systems, etc.).

This will allow to effectively tackle looming deficiencies through targeted research.

The SES implementation initiative SESAR covers definition, design, development and ultimately deployment of the future European air transport system through a masterplan that is enabled by the aforementioned SES legislation.



Long-term traffic growth trends for Eurocontrol Statistical Reference Area (ESRA)

Moreover, it is hoped SESAR will provide institutional arrangements needed to allow for wider harmonisation and co-operation across the ATM industry leading to improved decision-making. The ultimate outcome should be a safe, efficient, seamless and harmonised air transport system benefiting the whole of Europe.

On the technical side, SES objectives translate into the need for substantial investment in new technology, systems and training and changes to Air Navigation Services Providers' (ANSPs) operating concepts, procedures and charging schemes.

For the 2005-2012 timeframe, research will have to focus on validating already identified options to allow clear decisions on their deployment, and on achieving interoperability convergence by supporting early specification of future components and systems. Interoperability in the SES regime will be progressively implemented, based on the SESAR outputs, and will be fully achieved by the year 2020, with research into more innovative solutions to face the challenge of the traffic increase.

These ambitious goals clearly imply that a lot of efforts are needed to:

- Reduce the fragmentation of the European aviation market;
- reduce unnecessary costs through reorganisation;
- enhance compatibility and interoperability of ATM systems;
- reinforce and improve overall safety;
- foster technological innovation in airborne and ground systems through the opening-up of markets thus strengthening the entire ATM industry;
- increase capacity to meet demand; and
- simplify the regulatory framework.

With a particular view to research and development, SESAR is meant to co-ordinate, synchronise and integrate all efforts thus allowing for the full exploitation of research findings. By bringing together all key stakeholders from industry, regulatory authorities and the institutional side, SESAR will ensure that emerging organisational and technical issues are addressed in a comprehensive, cost-efficient and beneficial way.

The current SESAR work programme hence directly translates into areas of relevance for ongoing and future research efforts by comprising:

- A regulatory and business framework;
- performance requirements and assessment criteria;
- technical and operational changes to enabling ATM systems;
- validation and simulation needs; and
- the top-level ATM master plan.

Research activities in the aviation sector will have to be judged against SESAR's guidelines to produce outputs that are quantifiable, recognisable and in overall beneficial to airspace users and their customers, and the ATM industry. Hence targeted objectives are to:

- Achieve cost-efficiency through joining forces in R&D and avoiding the present fragmentation in system implementation and infrastructure deployment;
- provide lower costs of ATM system procurement and maintenance based on better validated requirements, harmonised standards, certification and licensing;
- achieve industrial co-operation (and possibly consolidation) at the European level;
- establish European (or even global) standards; and
- speed up the deployment of standardised ATM components and systems.

3 RELEVANT RESEARCH PROGRAMMES AND PROJECTS

For many years research activities at the European level have been looking into technical developments and organisational schemes related to a variety of aspects connected to what evolved into the Single European Sky (SES) initiative. Notably, the European Commission, Eurocontrol and several national aviation authorities joined forces to develop, validate and later on implement a future European Air Traffic Management System (EATMS) building on Eurocontrol's original ATM 2000+ strategy.

Drawing on valuable scientific findings, devised validation platforms and operational concepts from the Fourth Framework Programme's 'Transport RTD Programme', the following on-going research programmes are some examples of activities which do significantly contribute to the SES initiative:

- Fifth Framework Programme, Growth/Key Action 4 'New Perspectives in Aeronautics';
- Sixth Framework Programme, Thematic Priority Area 4 'Aeronautics and Space';
- Trans-European Transport Networks Programme (TEN-T); and
- Eurocontrol programmes.

Topics covered in projects from the above research programmes comprise:

- Improving airport infrastructures and airport operations;
- validating ATM technical components and devising more efficient airspace structures;
- developing aircraft systems that complement ground infrastructures while complying with future air traffic control, guidance and navigation equipment;
- enhancing human capabilities in progressively technological advanced working environments;
- addressing safety requirements for all phases of air transport operation; and
- implementation strategies that address the long-term character of the SES concept, calling for its full availability by the year 2020.

4 RESEARCH RESULTS

A wide range of research projects has dealt with the need to come up with novel ATM environments, an open system architecture with long-term growth potential, and a much more efficient organisational framework for redesigning airspace use and related ATC services.

Co-operative Air Traffic Management for Europe

Past research activities have come up with a wide range of novel architectures, technical and operational solutions as well as organisational aspects of Air Traffic Management. However, a major challenge remains the integration of individual components into a co-operative future ATM environment such as:

- Communication Navigation and Surveillance (CNS) concepts;
- Airborne Separation Assistance System (ASAS) procedures;
- 4D Flight Management System (FMS) capabilities and trajectory planning;
- air-ground data-linkage;
- system-wide information management;
- advanced tools to support separation management;
- flight data processing and flow management; and
- some initial system wide collaborative decision-making applications.

This will be mainly achieved through a comprehensive simulation and validation programme with a target horizon of 2012 for initial deployment of this major SES building block.

Towards a collaborative ATM network

The operational ATM concept developed by the AFAS (Aircraft in the future Air Traffic Management system) project has been based on:

- Air-to-ground data-link exchanges and sharing of information among airports, airlines and air traffic control (ATC); and
- the use of computed four-dimensional flight trajectories for ATC operations exploiting advanced Flight Management Systems (FMS) available in modern commercial aircraft.

This extension of the collaborative decision-making process has clearly improved the predictability of flight trajectories leading to more efficient flow management and airport operations. Two technical and operational validation exercises have confirmed:

- The high maturity of available avionics packages; and
- a potential for significant ATM enhancements thanks to better air-to-ground coordination.

Efficient and integrated operations from gate to gate

Though extensive research efforts have been undertaken to come up with highly interoperable, efficient and safe ATM concepts and components, the complex validation of an integrated gate-to-gate ATM operational concept had not been done before. GATE-to-GATE, the biggest and most ambitious air sector research project from Fifth Framework Programme (FP5) has been set up to undertake this research.

In order to prepare for the future, this project is proposing an integrated operational framework for implementation from 2010 onwards. Linking departure, en-route and arrival, GATE-to-GATE is aiming at an integrated operational concept comprising:

- Traffic flow planning managed prior and along all flight phases, based on four dimensional planning (4D, including time) trajectory exchange between stakeholders; and
- continuous optimisation of the planning process taking into account unexpected events, allowing for more anticipation during all phases of flight plus some delegation of tasks from the controller to the pilot leading to benefits in safety, capacity, cost efficiency and punctuality.

Redesigning European airspace

ONESKY (One non-national European sky), a major study employing fast time simulation techniques, has evaluated two different approaches to redesigning European airspace across national borders:

- A bottom-up development based on current airspace design, proving the effectiveness of redesigning even a limited amount of existing ATM sectors; and
- a top-down, clean sheet design of ATM regions dramatically increasing overall system capacity.

Both scenarios were investigated using the operational concepts of flexible use of airspace (FUA), direct routing and reduced vertical separation minimum (RVSM). Additionally, the impacts of airspace controlled by the military have been taken into consideration.

The bottom-up approach was developed for four important ATM regions in Central and Southern Europe, while the clean sheet design looked into Scandinavian as well as Central and Southern European control areas. The scenarios were backed up by cost-benefit analyses which proved the general viability of both approaches, though the radical concept promised more substantial economic and capacity benefits.

While many activities aim at enhancing overall ATM capacity, it must not be forgotten that ground infrastructures need to cope with the forecast growth in aviation as well. Hence, airports need to increase their system capacity and enhance operational safety, at the same time addressing environmental impacts such as noise in the vicinity. Moreover, large new-generation widebody aircraft such as Airbus A380, Boeing 777, Airbus A340 and proposed growth versions of Boeing's 747 highlight the need to reassess aircraft separation rules that increasingly prove to be conservative thus unnecessarily limiting airport and ATC capacity.

Keeping airports moving

Tackling looming capacity problems at airports has been identified as a primary goal for many years. The development of Advanced Surface Movement, Guidance and Control Systems (A-SMGCS) has progressed significantly thanks to research efforts in recent Framework Programmes.

To fulfil the promise of a highly efficient air transport system that operates at much higher safety standards, premium punctuality and significantly reduced costs, A-SMGCS is seen as a promising comprehensive approach to boost airport performance through integrating it with route planning, guidance and control in ATM.

In a two-pronged approach, the EMMA project (European Airport Movement Management by A-SMGCS) will help validate and mature the existing A-SMGCS architecture with a view to establishing standards relating to technical and operational procedures, safety and interoperability. EMMA has also ensured a common standardised validation method by developing analysis and verification tools. In addition to simulation, in-situ trials at three major airports – Milan-Malpensa, Prague-Ruzyne and Toulouse-Blagnac – will help prove the suitability, comprehensiveness and readiness of technical and operational requirements before Europe-wide implementation of A-SMGCS commences.

Wake vortex prediction and detection

A set of mature technologies to detect and predict wake vortices generated by aircraft is now seen to allow for the introduction of flexible separation minima dependent on predictors as well as ICAO aircraft categories.

ATC-WAKE (Integrated Air Traffic Control wake vortex safety and capacity system) has proposed:

- Determining separation modes for approach and departure with a forecast time of 20-40 minutes, based on wake vortex behaviour prediction dependent on weather conditions;
- tactical controller decisions during approach following the pre-determined separation mode using short term wake vortex prediction and detection information; and
- departure operations following the pre-determined separation mode, again using short term wake vortex prediction and detection information, during take-off and climb-out.

Moreover, the project has specified procedures for the transition from ICAO standard separation to ATC-WAKE separation modes, and for staggered approaches to closely spaced parallel runways like the two main runways at Frankfurt Rhein/Main airport.

Implementing noise abatement procedures at airports

While many European airports are facing calls for capacity growth and efficiency enhancements, their neighbourhoods expect measures to be taken against environmental impacts, with noise being the number one concern. Also, ICAO's balanced approach for a more environmentally friendly aviation industry stresses noise mitigation as an important action item.

SOURDINE II (Study of optimisation procedures for decreasing the impact of noise around airports II) has addressed the when, where and how of noise abatement procedures to be considered in the context of:

- Reduction at source (e.g. favouring aircraft with new technology engines);

- operational procedures (e.g. thrust setting and flight path);
- operating restrictions (e.g. curfews, limitations in the size of aircraft); and
- land use control (affecting the vicinity of airports).

The most promising operational procedures are aiming at considerable mitigation effects during aircraft approach and departure through changed engine thrust settings and adapted flight paths.

In addition, the study has investigated the roles of stakeholders, such as nearby communities, airlines, ANSPs, airports and regulation authorities.

Complementing the required step change of ATM organisation and operation over Central Europe, advanced data link technology and the automatic distribution of ATC responsibilities to intelligent aircraft are seen as viable and efficient ways of improving ATM performance initially in less congested control areas such as the Mediterranean and Scandinavia.

The role of aircraft

To accelerate the move to greater aircraft autonomy, supporting the increasing demand for air travel in and around Europe, the MA-AFAS (The more autonomous – Aircraft in the future Air Traffic Man-agement system) research project helped:

- Foster the more efficient and flexible use of airspace;
- optimise the use of airport capacities and facilities;
- allow for the more efficient use of aircraft through optimised 4D trajectory routing, employment of Airborne Separation Assistance Systems (ASAS), enhanced fleet management and Collaborative Decision Making (CDM) support; and
- enable weather independent operations.

Among the functions of ASAS systems that help boost air traffic capacity are manoeuvres being delegated to aircraft en-route such as:

- Longitudinal spacing (remaining or merging behind leading aircraft);
- lateral spacing (passing behind other aircraft, or lateral offset for overtaking leading aircraft); and
- vertical crossing (coordinated crossing over or below other aircraft, then automatically resuming climb or descent to designated flight level).

Moreover, improvements to taxi movements on the ground provide for better orientation, increased safety, enhanced situational awareness, and fewer runway incursions.

Trialling free flight over the Mediterranean

The MFF (Mediterranean Free Flight) project has come up with consolidated results and recommendations on Airborne Separation Assistance System (ASAS) applications obtained from a significant number of simulations, flight trials and studies. It has investigated the possibilities to establish free flight zones over the Mediterranean Sea which constitutes a transition area from Europe's highly used but well equipped ATM regime to Northern Africa's less populated airspace with poor surveillance infrastructure. During three major real-time simulations, ASAS Self Separation zones (Free Flight) were found to:

- Be viable, with no insurmountable safety issues in low traffic load areas;
- be well accepted by both pilots and controllers;
- effectively support the transition between 'Managed' and Free Flight airspace through intent information;
- yield benefits due to more direct flight paths resulting in fuel savings and less radar surveillance;
- result in only a small increase in pilot workload; and
- be very beneficial for air transport operations.

A key enabler for ATM improvement

The introduction of automatic dependent surveillance (ADS-B) technology is set to change the way flight operations are to be run in an environment that promotes delegating more responsibilities to aircraft. The NUP II (North European ADS-B network update programme Phase 2) project has looked into:

- Enhancing ATC capabilities through the use of ADS-B components – on the ground and on aircraft – with a view to operation in non-radar environments, and airport surface movements; and
- introducing air-to-air surveillance and control capabilities through installation of ADS-B cockpit equipment.

The project's main task has been to ready key ADS-B systems for operational introduction in a European ADS-B network by validating pre-operational ATM concepts. It has set up an infrastructure comprising of over 30 ADS-B ground stations and more than 30 ADS-B equipped aircraft and helicopters, as well as several types of ATC integrations of ADS-B.

The second stage of NUP II was to introduce down-linking of 4D trajectory data from the aircraft Flight Management System (FMS) to the ground, on more than 20 SAS and Austrian Airlines aircraft, to give more predictable trajectory information to airports, air navigation service providers and airlines hereby:

- Facilitating improved air traffic management efficiency;
- supporting better Collaborative Decision Making (CDM) processes; and
- enabling routine operational use of Continuous Descent Approaches to reduce environmental impact (preliminary results show a reduction of up to 100kg of fuel burn/approach)

The goal is to see if using 4D data to manage arrivals more predictably can increase the number of operations that can be handled by one runway from the current 45 to 60.

5 BENEFITS GAINED FROM THE RESEARCH

Among the technological highlights from completed research projects have been developments such as:

- The standardised AVENUE validation platform for ATM components needed to proceed from the definition and design phase to subsequent implementation of future ATM systems and equipment;
- novel Communications, Navigation and Surveillance (CNS) applications related to precision navigation capability en-route and during approach, apron situational awareness and taxi guidance, in-flight situational awareness, enhanced ATC surveillance, automatic terminal information service broadcast, and runway incursion monitoring; and
- an extensive simulation and demonstration campaign proving the usefulness of Advanced Surface Movement Guidance and Control Systems (A-SMGCS) through live trials at three major European airports.

Several research activities have proven that more integrated ATM systems comprising:

- State-of-the-art ground based ATC;
- intelligent aircraft on-board systems integrated with flight management systems;
- autonomous surveillance and aircraft separation assistance technology;
- improved data link and communications technology; and
- real-time exchange of important information for flight planning and operations.

These can substantially change the way of providing air traffic control, thus coping with growth demands and the need to maintain and improve safety standards of the entire ATM system. This networking character of future system architectures and technical components contrasts past developments that have often optimised single technical systems but have failed to generate synergies. The consequence has been systems that cannot provide the desired major steps forward in terms of efficiency, costs, reliability and safety.

The maturity of real-time data link technology, for example, has paved the way for pre-deploying Automatic Dependent Surveillance (ADS-B) technology, itself enabling the introduction of free flight zones in less congested airspace in Scandinavia and over the Mediterranean Sea. As similar schemes are underway in the US and Australia, the implementation of such a technology in Europe shows its importance on a global scale. While the introduction of free flight zones has proven to be beneficial under most circumstances, the transition from conventional ATC (managed) sectors to free flight zones will require further investigation.

Another area where benefits gained from recent research activities have become apparent is the introduction of integrated traffic flow management, e.g. through the use of 4D trajectories for planning, monitoring and adjusting of flight plans. Looking at the entire flight service (from departure and climb, through cruise, to approach to the destination airport) has led to considerable improvements in capacity, safety, cost efficiency, environment, punctuality and flexibility.

These results and many others from ongoing research activities will become cornerstones of tomorrow's single, harmonised European airspace.

6 EUROPEAN **POLICY IMPLICATIONS**

The definition phase of SESAR will by early 2008 have devised the European ATM Master Plan and a detailed work programme for 2008-13. SESAR will become the most important industrial venture to pave the way for the implementation of the Single European Sky.

The major observed weakness of initiatives to revamp ATM in Europe over the past 20 years has been decision-making. While research efforts of a wide group of stakeholders has yielded considerable advances in technology – which in many cases is now available for operational deployment – this is not enough and the actual implementation has always lagged behind. This is why EC policy has initiated the launch of *SESAR* which in the meantime is widely accepted as *a unique opportunity to*:

- Join forces with all stakeholders involved such as Member States, industry, ANSPs, airports, airspace users, the military, international, professional and technical organisations (Eurocontrol, ICAO, IATA, EURO-CAE, etc.) and possibly third countries;
- ensure a legislative, organisational and technical framework for all activities;
- come up with a robust multi-player and long-running funding scheme;
- foster further advances in research and development of systems and components;
- pave the way for the incremental deployment of new technologies over the next 15-20 years to meet operational, safety and efficiency requirements;
- provide for an appropriate management umbrella; and
- ensure that relevant stakeholders mentioned above 'remain around the table' throughout the entire development and implementation phase.

Clearly a massive task such as implementing the vision of a harmonised European airspace will require adequate management, supervision and control at the EU level. An independent study[10] into the options for governance of SESAR's development and implementation phase has confirmed a Joint Undertaking – similar to the one successfully pursued for the Galileo satellite navigation system – as the most promising contender. The right governance scheme is understood to be key to the overall success of SESAR, focusing on the following objectives:

- Efficient decision-making;
- co-ordination, synchronisation and harmonisation of all efforts across Europe;
- a holistic system-wide approach towards integrating all aspects of air transport, such as air and ground operations, into one trunk of research and development activities;
- the efficient management and use of resources with a focus on strengthening synergies; and
- the appropriate participation of key stakeholders such as Member States, industry and Eurocontrol.

10. 'SESAME CBA and governance – Assessment of options, benefits and associated costs of the SESAME programme for the definition of the future air traffic management system'; Steer Davies Gleave, London, draft final report, May 2005

The European Commission has proposed a Joint Undertaking for inclusion in the Seventh Framework Programme that asks for a wide co-operation and consensus among mentioned key players, and secures targeted funding at the EU level. Financing will have to exploit EU RTD and TEN-T funding as well as significant industry contributions. All these funding streams need to be merged into a comprehensive, consistent and programme-oriented multi-annual budget to ensure the effective development and implementation of the future European ATM environment.
While the SESAR initiative gathers together key stakeholders in its current definition phase – securing a harmonised European airspace framework and ATC environment with a wider global view to interoperability of future systems – a lot of responsibility for actual development and deployment of SES building blocks will be assigned to States, ANSPs, airspace users and airports supported by industry.

7 FUTURE RESEARCH DEVELOPMENTS

The current way of 'doing' ATM is not sustainable and will not provide the necessary levels of capacity, safety, efficiency and cost effectiveness that will be required to enable the air transport system to function efficiently and effectively from 2020 onwards. It is generally accepted that the future ATM system needs to be radically different, based on a collaborative ATM process with greater system automation and wider exploitation of aircraft capabilities. Precision navigation, coupled with data link capability, will enable a more effective planning process and a delegation of responsibility for separation to the cockpit. The ground ATM system should ensure overall system efficiency and organise traffic to maximise system capacity, whilst the aircraft should assume responsibility for ensuring separation from other aircraft and arriving at 'the right place at the right time', as agreed between the ground ATM, the airline and the airport through 'collaborative decision making' processes.

The Single European Sky legislation has laid the regulatory basis for a radical restructuring of ATM in Europe and the R&D activities carried out provide the key elements for future system development. These two threads are brought together by the **SESAR** programme which, in the **Definition Phase**, will establish a common agreed position by all the ATM actors on the required performance and necessary development of the future European ATM system to satisfy future traffic growth. The main focus for R&D in Europe for the 2008-13 time period will be the SESAR **Development Phase**: the realisation of the future system through the development and validation of the overall system design and its constituent components to be implemented in the **Deployment Phase** between 2014 and 2020.

The main thrust of this work will be to:

- Validate that the selected concept from the SESAR Definition Phase will meet the required system performance requirements;
- carry out the necessary research and development to ensure that the required systems and sub-systems have the required performance and are available as and when needed;
- provide the necessary information for the decision making process to support implementation; and
- explore and prepare the longer term solutions for later system performance upgrades.

Even the achievement of this research will be radically different from the past, where national and European level research (European Commission and Eurocontrol) have tended to be conducted in isolation, even if there has been a certain degree of 'co-ordination'. The characteristic of ATM research for the future will be that it will be carried out in a fully integrated manner where all European and national initiatives will be channelled through a single 'programme office' in the form of a **SESAR Joint Undertaking** which will regroup the European Commission, Eurocontrol and national and/or industry funding to the level of 300 million euros per year to achieve the SESAR Development Phase.

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GLOSSARY

ADS(-B)	Automatic Dependent Surveillance (Broadcast)
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
ASAS	Airborne Separation Assistance Systems
A-SMGCS	Advanced Surface Movement, Guidance and Control System
ATA	Air Traffic Alliance, industrial grouping of EADS, Airbus and Thales, contracted for the definition phase of SESAR
ATC	Air Traffic Control
ATM	Air Traffic Management
CDM	Collaborative Decision Making
CNS	Communications, Navigation and Surveillance
DG TREN	European Commission, Directorate-General for Energy and Transport
EADS	European Aeronautic Defence and Space Company
EATMN	European Air Traffic Management Network
EATMS	European Air Traffic Management System
EC	European Commission
Eurocontrol	European Organisation for the Safety of Air Navigation
FAA	(US) Federal Aviation Administration
FAB	Functional Airspace Block
FL	Flight Level, given in hundred feet above sea level
FMS	Flight Management System
FUA	Flexible Use of Airspace
Galileo	(European) Global Satellite Navigation System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
NGATS	(US) Next Generation Air Transportation System
RVSM	Reduced Vertical Separation Minimum
SESAR	Single European Sky air traffic management research; Definition phase consortium (www.sesar-consortium.aero) partners include: • Airspace users: Air France, Deutsche Lufthansa AG, Iberia, Association of European Airlines (AEA), European Regions Airline Association (ERA), International Council of Aircraft Owner and Pilot Association (IAOPA), International Air Transport Association (IATA), KLM. • Airport operators: Aéroports de Paris (ADP), Aeropuertos Espanoles y Navegacion Aérea (AENA), Amsterdam Airport Schiphol, British Airport Authorities (BAA), Fraport AG, Luftfarts verket (LFV), Munich International Airport. • Air navigation service providers: Aeropuertos Espanoles y Navegacion Aérea (AENA), Austro Control GmbH, Deutsche Flugsicherung GmbH (DFS), Direction des Services de Navigation Aérienne (DSNA), Società Nazionale per l'Assistenza al Volo (ENAV), Luftfartsverket (LFV), Air Traffic Control The Netherlands (LVNL), National Air Traffic Services (NATS), NAV Portugal. • Supply industry: Airbus, Air Traffic Alliance, BAE Systems, EADS, Indra, Selex Sistemi Integrati, Thales ATM, Thales Avionics. • Associated partners: Air Traffic Controllers European Union Co-ordination (ATCEUC), Boeing, Civil Aviation Authority UK, Dassault, ECA, ETF, European ATM Military Directors Conference (EURAMID), International Federation of Air Traffic Controllers' Associations (IFATCA), International Federation of Air Traffic Safety Electronics Association (IFATSEA), Honeywell, Rockwell-Collins. • Research centres: AENA, DFS, DLR, DSNA/DTI/SDER, INECO, ISDEFE, NLR, QinetiQ Ltd., SICTA, SOFREAVIA.
SES	Single European Sky
TEN-T	Trans-European Transport Network

SESAR, the Single European Sky implementation programme jointly funded by the European Commission and Eurocontrol through the TEN-T scheme, is the unique opportunity to make the vision of a Single European Sky in air transport become a reality by the year 2020. One of its definition phase milestones will be to devise an Air Traffic Management masterplan by early 2008, defining common goals and required developments of European air traffic control infrastructures. This brochure highlights SESAR's scope and its impact on the overall Single European Sky scheme by looking at recent research, live trials, studies and advances in technical equipment, as well as its legislative and organisational framework.