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**Long Term Innovative Research – A Framework**  
**within the SESAR Joint Undertaking**

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The Single European Sky ATM Research (SESAR) activities and the corresponding Joint Undertaking (SESAR JU) are currently subject to numerous publications, discussions and questions. This article will cover the basic background of SESAR, the underlying process its current status and the Long Term Innovative Research (LTIR) Programme.

### **The Air Transport System - Challenges**

Mobility is one of the most essential demands of today's society world-wide. Economical growth and development urgently require highly reliable modes of safe, efficient and environmentally friendly transportation of passengers and goods. Being part of the global inter-modal mobility network, the air transport system has developed continuously to meet the challenges of growing demand in quantity and quality of transport capacity. Considerable improvements in ATM systems, aircraft systems, airports' technical equipment and organisational structures have been achieved so far.

Nevertheless, the desired breakthrough towards a highly interoperable, safe and cost-efficient air traffic regime remains pending. One potential reason for this may be seen in the fragmentation of technology, national rather than operational considerations and a questionable level of uncoordinated and parallel developments in procedures, technology and systems.



Photo: Fraport AG

### **The SES initiative**

To overcome this difficulty, an initiative was launched in 1999 under the name Single European Sky. The SES lays down the legislative and regulatory foundations for future actions. Four European Commission regulations were adopted in 2004, defining the scope of required activities. These are:

- **The framework regulation** establishing a harmonised institutional and regulatory framework for the creation of the SES,
- **The service provision regulation** establishing requirements for the safe and efficient provision of these services in the Community,
- **The airspace regulation** establishing the conditions and requirements for creating transnational functional airspace blocks, and
- **The interoperability regulation** aiming at achieving the interoperability of the European Air Traffic Management Network [1].

The SES framework is complemented by the “Single European Sky ATM Research” programme. SESAR is intended to pave the way for the

implementation of technical, operational and organisational changes and improvements.

### **SESAR: definition – development - implementation**

Being the “operational” part of the legislative packages of the Single European Sky initiative, SESAR proposes a new approach to reform the ATM structure in Europe. For the first time in the history of air transport research, an integrative and co-operative approach among all stakeholders has been chosen. Within three subsequent phases, a commonly agreed European ATM Master Plan is being defined, developed and deployed.

- Definition phase (2005-2008) delivers an ATM master plan defining the content, the development and deployment plans of the next generation of ATM systems.
- Development phase (2008-2013) produces the required new generation of technological systems and components as defined in the definition phase
- Deployment phase (2014-2020) is a large-scale production and implementation of the new air traffic management infrastructure, comprising fully harmonised and interoperable components which guarantee high-performance air transport activities in Europe.

**The “Definition Phase”** aimed at the establishment of a commonly agreed European ATM Master Plan. A 30-partner consortium led by Air Traffic Alliance succeeded in producing 6 highly acknowledged deliverables (D1-D6). These reports cover the whole chain from the analysis of the current ATM framework situation up to a recommendation for the future Work Programme.

**D1** : Air Transport Framework - the Current Situation

**D2** : Air Transport Framework - the Performance Target

**D3** : Definition of the future ATM Target Concept

**D4** : Selection of the “Best” Deployment Scenario

**D5** : Production of the SESAR ATM Master Plan

**D6** : Work Programme for 2008 - 2013



The individual expertise of major organisations involved in the air transport system as, for instance, airspace users, air navigation service providers (ANSPs), airports and the supply industry was combined to form the results of the definition phase in a consistent way. A number of associated partners, including safety regulators, military organisations, pilot and controller associations and research centres working together with Eurocontrol supported this process.

The European ATM Master Plan and the corresponding Work Programme now form the basis for the transition from the definition phase to development and implementation.

### **SESAR JU - The Joint Undertaking**

Taking into account the number of parties being involved in SESAR and the financial resources and technical expertise needed, a legal entity capable of ensuring the management of the funds assigned to the SESAR project during its development phase was created. On 27 February 2007, the SESAR Joint Undertaking was established under European Community law. The SESAR JU is responsible for

- securing the appropriate funding for the Programme, and focusing all relevant European Research and Development resources on SESAR;
- defining and updating the SESAR work programme in accordance with the work progress;
- ensuring consistency, efficiency and technical progress on all items of the work programme;
- reporting on the development phase results and preparing relevant actions for the implementation of these results.

The governance of the SESAR Joint Undertaking is ensured by the Administrative Board and the Executive Director. The Administrative Board is composed of representatives from each of the members of the Joint Undertaking as well as representatives from stakeholder groups. The Administrative Board is chaired by the representative of the Commission.

In 2007, the Administrative Board appointed Mr Patrick Ky as Executive Director of the SESAR Joint Undertaking. The Executive Director is responsible for the day-to-day management of the Joint Undertaking and is its legal representative.

Currently, the SESAR JU is in the process of building up the underlying organisation to full operability. At the same time, a process was started to extend the number of members in order to strengthen the basis on which the activities during the development phase of SESAR are managed and pushed forward. Starting with the two founding members, the European Community represented by the European Commission and EUROCONTROL, represented by its Agency, membership negotiations with 15 pre-selected candidates and 4 proposed candidates for later accession are being carried out. It is expected that the membership process will be finalized shortly.

## The Work Programme and Long-Term Innovative Research

The work programme is the main guidance along which the development phase will be carried out. The first level of the “Work Breakdown Structure” (WBS) of the development framework consists of five major work packages WP A to WP E covering the work programme management (WP A), the target concept and architecture maintenance (WP B), the master plan maintenance (WP C), the ATM network R&D programme (WP D) and the long-term innovative research programme (LTIR, WP E).

Work Package D itself consists of a consolidated and integrated Work Programme called “ATM network R&D programme”. It is made up of another 16 WPs covering transversal threads, operational threads, system threads and threads concerning the “System-Wide Information Management“ (SWIM). It aims at developing new SESAR Operational Improvements and associated enablers progressively for the integration into the European ATM network in order to enhance its capacity, safety and efficiency.

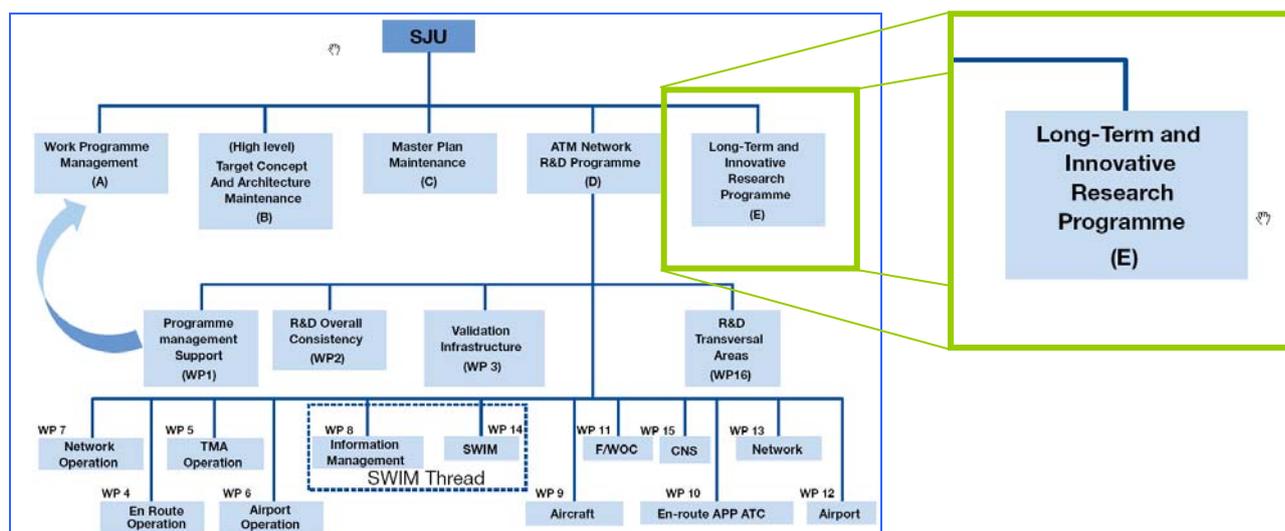


Figure 1: First level of WBS of the SESAR development framework [2].

For the scientific community, Work Package E titled “The Long-Term and Innovative Research Programme” (LTIR) is of specific interest. Currently, the scope of WP E is being refined and detailed. Proposals for the instruments of the LTIR Programme, such as SESAR Research Projects and SESAR Research Networks are discussed and a potential management framework is in the process of being defined. It is expected that within the coming months the Administrative Board will decide on the proposals. Consequently the LTIR Programme is expected to be launched immediately and a vital ATM research environment will be established.

### The need for long-term & innovative research

Arguments for a positive approach to long-term research and innovation in all branches of industry are well understood. In particular, the need to build the European economy on strong foundations of knowledge, research and innovation is forcefully reiterated in many EU declarations and treaties, and is seen as the key to growth, jobs and prosperity.

This is as true for air transport and ATM as it is for any other industry. It is vital that research competence is built and maintained so that Europe can play a significant and lasting role in the global arena, and for this a framework is needed that will maximise potential returns in this traditionally under-funded area.

The SESAR Definition Phase acknowledged that need. Deliverable D4 states that *“...it is very important that creativity and innovation are stimulated today in preparation for the future improvements and that appropriate levels of investment funds and resources are put in place to address these planning horizons, i.e. beyond the 2020 target ... As with other industrial sectors, ATM research should be promoted within academia, serving the dual purpose of stimulating creativity whilst preparing staff for tomorrow’s applications.”*

In order to address this, a specific workpackage, Workpackage E (WP-E), was proposed and subsequently retained as part of the SJU’s work programme.

### The WP-E vision

The contribution of WP-E will be twofold: First, it will be a catalyst to create a healthy European research capability for ATM and related air transport that will persist beyond the lifetime of the SESAR development programme (the SJU). Secondly, it will make provision and provide funding for research activities that are not currently planned within the ‘mainstream’ SESAR workpackages. Such research will address applications that will become operational beyond the SESAR timeframe (nominally 2020), and will also allow for innovative work that may have application in the nearer term.

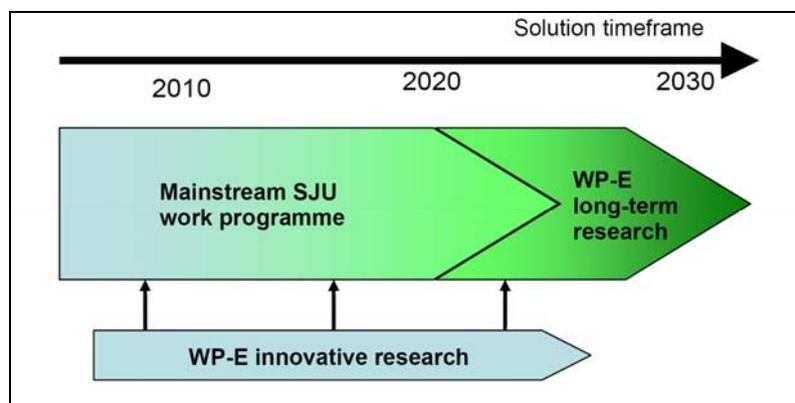


Figure 2: Scope of work package E (graphics: SESAR JU )

## **How WP-E works**

WP-E will use two functional instruments:

Research networks provide a structured way to build research knowledge, competence and capability that should serve the industry in the long term. Each network will be made up of partners from academia, research establishments, industry etc. that share a common expertise or interest in a relevant air traffic management or transportation domain.

Research projects will explore new ideas essentially for the long term, but which may also be targeted at innovations applicable in short- and mid-terms. As with the networks, projects will be multi-disciplinary undertakings.

Networks and projects will be selected following open calls. The first call for network proposals is imminent and will, assuming bids of sufficient quality are received, result in 3 networks being launched by the end of the year. This will be followed by further calls in early 2010 for PhD studies (which are expected to be 'hosted' by the networks) and projects. The total number of funded activities will depend on the overall cash budget available to WP-E, which is currently set at €23m.

## **Research Themes**

The research themes were developed following consultation with experts in academia, industry and research organisations as well as the SJU and the European Commission. Principal considerations were the potential for added value to the existing SESAR work, the need to think beyond the current SESAR timeframes and the potential for paradigm shift. In addition, it is a stated objective of WP-E to try to engage new academic disciplines in ATM research, and finally it is necessary to avoid overlap with other European activities (e.g. CleanSky).

The number of themes is initially limited to four to provide the focus needed given the limited resources available. They will be reviewed and revised as necessary as the work progresses, with additional themes likely for second and subsequent calls. The themes serve as guidelines for those wishing to submit proposal for networks or projects. Themes are deliberately described at a high and broad level since it is expected that those proposing projects and networks will interpret and enrich them according to their own expertise.

Each of the four themes is briefly outlined below. More details are available on the web site, and in particular in the Thematic Programme, which is a downloadable document.

### **Theme 1: Exploiting 4D to the max**

This research theme will contribute to the concept of precision 4D trajectory operations, which are envisaged for the long-term. In particular it will allow for modelling and analysis of a system that makes extensive use of precision 4D trajectories. Research in this theme might cover:

- Modelling an ATM system that includes thousands of precision 4D flights and hence exploring performance capabilities and limitations with regard to elements such as capacity and safety;
- Developing design principles for a system based on precision 4D trajectory operations explicitly considering the requirements of all relevant ground and air subsystems; also developing principles for a standard trajectory algorithmic baseline including system-wide time synchronisation and controlled time of arrival (CTA);
- Implications for human controllers working in a precision 4D environment;
- The balance between a system based on precision trajectory operations and the need for flexibility and resilience.



Photo: Deutsche Flugsicherung GmbH

Since 4D trajectory-based operations are an integral part of the SESAR concept, some related work is already planned within other SESAR workpackages. This means that research undertaken here must be distinctive, and must represent a clear extension to mainstream developments.

### **Theme 2: Towards full automation**

The current SESAR Concept of Operations was developed with the requirement that “humans will constitute the core of the future ATM System’s operations”. This precept imposes significant constraints on conceptual thinking, so this theme gives an opportunity to push back the barriers and freely explore new automation possibilities. The research will therefore study the application of high degrees of automation to one or several components of the air traffic management system (with or without the involvement of human operators) taking into account transition issues. This may include:

- Understanding the benefits and limits of high degrees of automation, up to and including ‘full’ automation;
- Identifying which functions in the ATM system could and should be automated;

- Research covering algorithms, tools and prototypes;
- The integration of airborne and ground-based systems together with a heterogeneous user (aircraft) population in a highly automated environment;
- Assessing the performance of a highly automated ATM system with regard to criteria such as safety, reliability and quality of service.

Human factors, reliability and safety need to be considered in particular if varying degrees of automation are to co-exist across different ATM sub-systems.

### **Theme 3: Mastering system complexity**

This theme focuses on air traffic management as a system of systems, with the objective of characterising the sources and consequences of its complexity. This has the potential to provide valuable insight into the system-wide impacts of change that today may not be well mastered.

There are at least two broad areas of interest. The first is to understand the emergent behaviour of the overall system when changes are introduced in one or more subsystems. Many changes have been applied to ATM in recent years, in some cases without a full understanding of the potential consequences. SESAR also plans to make a large number of ‘improvements’, but will these changes make the overall system better or worse? Safer, or less safe? Could they have consequences that are hidden from traditional validation approaches? How and in what sequence should they be introduced? The science of complexity could help answer some of these questions.

The second area of interest concerns the overall architecture of an ATM system where modernisation can be a painfully slow process. An overriding concern for safety is often the excuse for the slow adoption of new procedures or technological changes. However, this argument does not explain why the airborne innovation cycle takes only 7-10 years, whereas for the ground system 15-20 years is the norm. Has the ATM system become too complex, too tightly coupled? Have we lost control of the interdependencies and feedbacks between its subsystems? Furthermore, one could ask whether problems of complexity are purely technical or whether they are at least partly institutional.

This research theme has the potential for suggesting resilient and agile designs which are more conducive to the safe and expeditious introduction of new technologies or operational procedures. Methodologies may be developed to help decide which local or subsystem changes will most effectively generate required performance improvements.

### **Theme 4: Economics and performance**

This theme looks at long-term economic and performance issues associated with the ATM system as foreseen in the SESAR concept and beyond. It is expected both to apply traditional methods and to develop innovative approaches. In

particular it will examine how economic factors can be used to drive new developments in the ATM system.



Photo: Fraport AG

This theme seeks to explore the application of new economic mechanisms to influence the future ATM system. The following are some considerations that will condition this research:

- Increased privatisation and corporatisation of ATM service providers, together with European regulatory developments, has resulted in a push towards performance-based costing of service provision with quality of service measured by metrics such as capacity and delay.
- The SESAR operational concept is built around the idea of a business trajectory which means that users of the airspace can request to fly based on how they value a trajectory, which itself is a function of their business model. This may significantly impact operations.
- Sensitivity to the environmental impact of aircraft (noise and local and global emissions) is giving rise to new schemes to make users pay for the 'right to pollute'. Charging policies together with trading and regulatory measures will become increasingly important, with an impact on operational procedures, business models and growth potential. Airspace and airport slots are other examples of commodities that will be increasingly attributed monetary value giving rise to further trading options.
- New business models (both airlines and ANSPs) may emerge to play an important role in future evolutions of ATM. In addition there may be a greater diversity of airspace users including more light jets, UAVs and other airborne systems that have varying and sometimes incompatible operational requirements.
- Innovative business analysis techniques (both quantitative and qualitative) may be needed to support the development and evaluation of new concepts.

### **WP-E Management**

WP-E is managed on behalf of the SESAR Joint Undertaking by a small team based at the EUROCONTROL Experimental Centre in Brétigny-sur-Orge, France. The SJU Scientific Committee (see below) will take a particular interest in Workpackage E to advise on thematic content and strategic direction.

For all issues concerning Workpackage E the web site is the definitive source of up-to-date information ([www.sesarju.eu/public/standard\\_page/wpe.html](http://www.sesarju.eu/public/standard_page/wpe.html)). In particular the Workpackage E Thematic Programme document, giving more details on the four initial research themes, can be downloaded.

### **The SESAR Scientific Committee**

In order to guarantee high level academic contribution to the SESAR programme the SESAR Joint Undertaking has recently established a Scientific Committee. This Committee will support the Executive Director and will give advice on scientific and methodological aspects of the work programme and on the scientific quality of its results in research and development. In particular, the Committee will play an active role in support of long term and innovative research. It will focus on:

- the scientific analysis of SESAR from different angles: economics, human factors, statistics, mathematics, computer science, physics, technology;
- the liaison between SESAR and the academic and scientific communities across Europe including education of the future “SESAR interested engineers & scientists” and
- the validity, scientific coherence and value of the SESAR results.

The Scientific Committee comprises 12 renowned European visionaries and leaders from academia and research institutes. The full list of members is given on the SESAR Joint Undertaking web site ([http://www.sesarju.eu/public/news/090818\\_scientific.html](http://www.sesarju.eu/public/news/090818_scientific.html)). The Committee is expected to start its activities in autumn 2009.

*"Having these personalities on-board will enable SESAR to build on sound scientific foundations. Thanks to the contribution of the Scientific Committee, SESAR JU will establish strong links with academic institutions conducting applied research of relevance to us. We strive for an innovative approach at SESAR and the input of the Scientific Committee will stimulate the technologists and engineers to think out of the box and deliver breakthroughs in ATM research."* commented Patrick Ky, Executive Director of the SESAR Joint Undertaking.

**Reference:**

This article is based on material from the following sources:

- [1] “The SESAR Initiative” by DG Energy and Transport
- [2] “Work Programme for 2008-2013 / Deliverable D6” Issued by the SESAR Consortium for the SESAR Definition Phase Project co-funded by the European Commission and EUROCONTROL
- SESAR JU website [www.sesarju.eu](http://www.sesarju.eu), especially the Thematic Programme (downloadable)
- SESAR Consortium website [www.sesar-consortium.aero](http://www.sesar-consortium.aero)
- EUROCONTROL, [www.eurocontrol.int](http://www.eurocontrol.int)