



# **Final Evaluation of the SESAR Joint Undertaking (2014-2016) operating under the SESAR 1 Programme (FP7)**

Final Report

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# **Final Evaluation of the SESAR Joint Undertaking (2014-2016) operating under the SESAR 1 Programme (FP7)**

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## **Abstract**

This report is the final evaluation of the SESAR Joint Undertaking (SJU) in executing the SESAR1 programme from 2007 to 2016 as required by Article 7 of the Council Regulation (EC) No 219/2007, amended by Regulation (EU) No 721/2014.

The evaluation was conducted between January 2017 and June 2017 by a team of independent experts and is based on expert opinion, relevant documentation, survey results, stakeholder interviews and data analysis.

The analysis complies with the requirements of the revised evaluation guidelines of the Better Regulation Package and covers the five main evaluation criteria: relevance, efficiency, effectiveness, coherence, and EU added value. In addition, the criteria: openness, transparency and research quality are considered.

# 1. EXECUTIVE SUMMARY

## Scope

This document presents the results of an evaluation of the SESAR Joint Undertaking (SJU) operating under the SESAR1 work programme during 2008 to 2016. The evaluation was conducted by a team of independent experts from January 2017 to June 2017. The evaluation is requested by the regulation establishing the SJU.

The following criteria were considered: relevance, efficiency, effectiveness, coherence and EU added value with additional consideration of: openness, transparency and research quality.

The evaluation is intended to inform the European Commission's views on the effectiveness of the SJU, of transport Joint Undertakings and the need for future initiatives using Public-Private Partnership as means of promoting R&D.

## What is the SESAR Joint Undertaking?

The SJU is responsible for the execution and management of the development phase of the SESAR programme - the technological pillar of the Commission's Single European Sky (SES) policy.

The SES was the Commission's response to the significant air transport delays that plagued the 1990s. The SES legislation promotes the development, modernisation, and harmonisation of Air Traffic Management (ATM) across Europe. Over the years SES has developed into a performance oriented system in which the service providers (or ANSPs) are incentivised to adopt new concepts and technologies (as well as new ways of managing the business) to achieve the SES High Level Goals:

- Increasing safety by a factor of 10;
- A tripling of capacity;
- A halving of unit costs; and
- A reduction of the environmental impact per flight by 10%.

Achieving these goals is a critical enabler for achieving sustainable Air Transport growth and hence growth within the wider EU economy in line with the Lisbon Agenda. The role of SESAR is to achieve modernisation of ATM using a classic three phase approach:

- **Definition:** In 2007 and 2008 a large industry consortia developed the first edition of the European ATM Master Plan – a blue print for the modernisation of ATM. It defined a new concept and the enabling systems to achieve the high level goals.
- **Development:** The SJU is responsible for the maintenance and execution of the European ATM Master Plan. To do so they manage a large and complex R&D programme that identifies and matures "solutions" required by the European ATM Masterplan. An important element of this work is to maintain the Master Plan so that it reflects changing needs – for example since the economic crash of 2008 the focus has been more on achieving the cost-efficient and environmental goals rather than the capacity goal which was considered critical in 2007.
- **Deployment:** Ensuring that the delivered solutions enjoy widespread implementation leading (alongside other developments in the industry) to the High Level Goals being reached. A separate but interrelated arrangement – the SESAR Deployment Manager - is responsible for the Deployment Phase.

These phases now constitute a continuous ATM modernisation lifecycle that includes regular updates of European ATM Master Plan to ensure that the overall SESAR programme remains relevant to the challenge of achieving the SES High Level Goals.

The current evaluation only considers the role of the SJU as the manager of the Development Phase.



## What are the main achievements to date?

For SESAR1, the SJU was established as an "EU-body" subject to EU Financial Regulations with an overall budget of €2.1Bn (in equal parts from the Commission, EUROCONTROL and the industry partners). The major achievements of SESAR1 were:

- Completion of over 400 projects, 350 validation exercises and 30,000 flight trials leading to...
- ...63 SESAR Solutions (new or improved operational procedures or technologies) of which...
- ...23 are mandated for deployment by the SESAR Deployment Manager under the Pilot Common Project Regulation; illustrating a...
- ...A strong and leading brand for ATM modernisation both within Europe and globally.

The success of SESAR is best illustrated by the European ATM Master Plan (SJU, 2015) and SESAR Solutions Catalogue (SJU, 2016). These two documents define the intent and output of the SESAR1 programme; together with the detailed results of the SESAR1 Programme (the Solution Packs) they have enabled Europe to play a leading role in setting global standards in ICAO and in particular in the definition of the Global Air Navigation Plan (GANP) (ICAO Doc 9750-AN/963, 2014).

The quality of the SESAR output is therefore not only illustrated by initial deployments of SESAR solutions by the SESAR Deployment Manager but also by the deployment of SESAR solutions on a voluntary basis both in Europe (for example Remote Towers in Sweden and Ireland) and globally (for example Abu Dhabi are currently evaluating implementation of both Remote Tower and Time Based Separation/EU RECAT).

## What are the main findings of the evaluation?

Throughout our evaluation SJU Members and ATM Stakeholders have highlighted the importance of **SESAR, and the SJU, as a key enabler of the wider SES policy**:

- The SJU and its Members have formed an unprecedented public-private partnership (PPP) that co-ordinated and concentrates effort and resources at European level to achieve modernisation of ATM.
- The Network investors (airlines, airports, ANSPs) are confident that this PPP is delivering the necessary solutions to achieve ATM modernisation.
- The partnership approach of "working together" has led to partnerships beyond the SJU scope (e.g. COOPANS, ITec, Borealis) that are leading to operational improvements across Europe.
- Manufacturers support the SJU because it provides access to operational stakeholders and hence improves their R&D leading to products with increased market potential.
- Whilst the wider supply chain of the manufacturers (and large ANSPs), typically made of SMEs, is not directly represented in the SJU Membership they are active in SESAR work programme through subcontracting arrangements and the various forms of membership, like Associate Member. The SJU has therefore led to a wide and inclusive participation in ATM R&D.

Overall the evaluation of the SJU under SESAR1 is extremely positive; but there is a word of caution. Progress is not as great as originally hoped for in the definition phase, for example key technical enablers such LDACS - the terrestrial replacement for VDL Mode 2 have not progressed sufficiently to de-risk some of the advanced concepts.

Further, the policy of concentrating R&D in the SJU limited the opportunities for academia in ATM R&D (due the limited budget available for WP-E). This would not be sustainable in the long term as it would restrict the availability of trained staff for future developments.

In terms of the main evaluation criteria:

<b>Effectiveness</b>	<p>The SJU has been very effective in organising the activities of the SESAR Development phase. This includes maintenance of the ATM Master Plan, delivering the R&amp;D programme and building European and international links to ensure global interoperability and European leadership in ATM solutions.</p> <p>For the main part the Work Programme has been successfully executed leading to 63 mature solutions. As expected with such a large programme (409 projects), some notable exceptions do exist – but the overall success rate is impressive.</p>
<b>Efficiency</b>	<p>Previous evaluations indicate that the SJU is compliant with the Regulations and efficient as an organisation. The SJU staff have successfully and efficiently managed a complex R&amp;D programme in a manner that has built a strong partnership for ATM modernisation.</p> <p>This is illustrated by the SJU's ability to simultaneously close the SESAR1 work programme and launch the SESAR2020 programme.</p>
<b>Relevance</b>	<p>The work of the SJU is assessed as having continued relevance to the ATM Stakeholders. The SJU and its Members are a strong partnership committed to achieving the SES High Level Goals. The successful maintenance of the European ATM Master Plan ensures that the SJU work programme maintains relevance as external factors evolve.</p> <p>The value of SESAR as a modernisation programme is now becoming obvious, with the successful launch of the Deployment Phase (through SESAR Deployment Manager) leading to European-wide deployment of SESAR solutions.</p>
<b>EU Added Value</b>	<p>The expected leverage for SESAR1 is 1.8 The value is consistent with a partnership – a near equal share of EU funding and private funding.</p> <p>Additional EU added is achieved through the collaborative partnership of the SJU and the momentum created for the modernisation of ATM and reaching the SES High Level Goals.</p>
<b>Coherence</b>	<p>The activities of the SJU have been evaluated as being coherent at four levels:</p> <ul style="list-style-type: none"> <li>• Internal – through maintenance of the Master Plan,</li> <li>• FP7 – through coordination with ACARE and Clean Sky,</li> <li>• EU- through the strong policy link with the SES and coordination with the wider SES actors including EASA, EDA, EUROCAE and the SESAR Deployment Manager,</li> <li>• Globally – through strong links with ICAO, the FAA (NextGen) and other national and regional programmes.</li> </ul>
<b>Openness and Transparency</b>	<p>The work of the SJU is considered to be open and transparent.</p> <p>The Administrative Board Minutes, Decisions, along with the accounts and annual reports are all publicly available.</p> <p>SJU publications are well received – particularly the European ATM Master Plan and SESAR Solutions Catalogue which together define the objective and results of the SESAR Development Phase. Each solution is supported by a detailed set of documentation (Solution Pack) designed to support implementation which are all publicly available.</p> <p>The SJU promotes SESAR at trade shows and other public events and is active on social media with a positive presence on LinkedIn and Twitter.</p>

Research Quality is assessed as excellent. The SJU Members provided world class researchers who developed high value deliverables. This is evidenced by the uptake of SESAR solutions both in Europe and worldwide.

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### **What Recommendations were made?**

Overall our conclusions are positive and reinforce the findings of the previous evaluations and support the extension of the SESAR Joint Undertaking. Our analysis suggests three potential areas of improvement. All three relate to how the activities of the SJU can support the longer-term role of SESAR as a modernisation programme with a strong link to the Single European Sky policy area.

#### **Rec 1: Strengthen the “partnership approach” including links to deployment**

With the launch of the SESAR Deployment Phase, the European ATM Master Plan has a growing importance beyond being a blue print for the necessary R&D. Rather it should be considered a strategy document for achieving the SES High Level Goals. In this regard, the European ATM Master Plan should further strengthen inputs from:

- The wider industry (whether a member of the SJU or not).
- The Performance Review Body on current performance and performance short falls.
- The Network Manager on how network functions should evolve and contribute to the SES high level goals.
- The SESAR Deployment Manager in terms of the support required to achieve widespread adoption of SESAR solutions.
- EASA in terms of how solutions can be regulated (from a safety perspective).

These connections already existed, but to some extent were managed in an ad-hoc manner. Master Plan update programmes can only benefit if the supporting activities become even more inclusive and secure greater transparency. It is recognised that the creation of the Master Planning Committee in SESAR2020 starts to address this issue.

#### **Rec 2: Strengthen the “architecture” of the Master Plan to enable the Commission to streamline deployment planning and monitoring.**

The European ATM Mater Plan consists of three layers:

- The Executive level which sets out the strategy for SESAR,
- The Planning and architectural view which sets out how SESAR elements contribute to the overall system; and
- The Implementation view which sets out the deployment of specific elements.

Currently all three views use different language to describe the same concepts. It is therefore difficult to assess their consistency. It is recommended that Level 2 is reorganised around the principles of SESAR solutions and that Level 3 is streamlined to include deployment monitoring activities of the SESAR Deployment Manager as well as voluntary reports from stakeholders, avoiding multiple reporting. In this way, the Master Plan can become an even more coherent tool for planning the overall SESAR deployment and monitor its achievement.

#### **Rec 3: Strengthen the links to academia to ensure the innovation pipeline is fed with new ideas**

As initially conceived, the SESAR Development Phase was a relatively short programme designed mainly to mature ATM concepts and technologies to accelerate their deployment. The focus was on concentrating the efforts of the industry (suppliers and

service providers) on the necessary development work. It was not deemed a priority to build links to universities in order to secure a pipeline of new ideas and future workforce.

It is now clear that SESAR is a long-term programme that needs to evolve to take account of influences beyond ATM and respond to new challenges facing the community – for example drones, cybersecurity, big data, machine learning, and new approaches to regulation. To achieve this, the links to academia need to be strengthened.

## **2. INTRODUCTION**

### **2.1. Purpose of the evaluation**

This report is the final evaluation of the SESAR Joint Undertaking (SJU) in executing the SESAR1 programme from 2007 to 2016.

The results of this evaluation will be used to inform the European Parliament and Council, national authorities, the research community and other stakeholders on the final outcome of the SJU under FP7. They will also be used to improve the implementation of the JUs in general and of the SJU in particular under Horizon 2020 and contribute to the formulation of the 2018-2019 SJU Annual work programmes and serve as a basis for the ex-ante impact assessment of a possible next generation JUs.

### **2.2. Scope of the evaluation**

This final evaluation of the SJU under SESAR1 is subject to Article 7 of the (Council Regulation (EC) No 219/2007), amended by (Council Regulation (EU) No 721/2014), which requires the Commission to carry out, with the assistance of independent experts, an interim evaluation on the SJU.

The analysis complies with the requirements of the revised evaluation guidelines of the Better Regulation Package and covers the five main evaluation criteria: relevance, efficiency, effectiveness, coherence, and EU added value with additional consideration of openness, transparency and research quality. The evaluation questions are summarised in Section 4.

The evaluation covers the entire period of SJU implementation of SESAR1 between 2007 and 2016 but in doing so it builds on the two previous interim evaluations published in 2010 (COWI, 2010) and 2014 (COWI, 2014). The core focus is therefore on the activities of the SJU during the period 1<sup>st</sup> January 2014 to 31<sup>st</sup> December 2016.

The original objectives of SJU originate from the political and socio-economic situation in 2006-2007. The evaluation covers the SJU objectives, as set out in Article 1(5) of the SJU's basic Regulation, whilst taking into account the emerging context, for example the impact of the financial crisis of 2008, and in particular considers the contribution of the SJU as an instrument towards achieving the EU's Single European Sky policy objectives.

### **2.2. Structure of the report**

The remainder of this report is structured as follows:

- Section 3: Sets out the context for the evaluation by providing background information on the SESAR Programme and the related Single European Sky Policy Area.
- Section 4: Sets out the evaluation questions.
- Section 5: Describes the evaluation methodology. Details of the surveys, reference material and interviews used to inform this evaluation are presented in the Annexes.
- Section 6: Describes the implementation of the SJU in terms of the budget, membership and work conducted. Statistics are provided in terms of the distribution of funds between members, Member States and research areas.
- Section 7: Provides the detailed analysis in terms of Effectiveness, Efficiency, Coherence, EU added value and Relevance.
- Section 8 sets out the conclusions to the evaluation.
- Section 9 provides recommendations to the SJU going forward.
- Section 10 provides the references used in this report.

This report is completed by the following annexes:

- Annex A: Glossary
- Annex B: SESAR1 Work Packages
- Annex C: SESAR1 Solutions
- Annex D: Bibliography
- Annex E: Interviews
- Annex F: Stakeholders Survey
- Annex G: Project Coordinators Survey

### 3. BACKGROUND TO THE INITIATIVE

The Single European Sky ATM Research (SESAR) programme is an initiative of the EU to modernise and harmonise Air Traffic Management (ATM) in Europe. SESAR is the technological pillar of the Single European Sky (SES). This section sets out the background to SESAR and establishes the policy context with the SES.

#### **3.1. Description of the initiative, objectives and relevance**

##### **3.1.1. SES and the initiation of SESAR**

Following severe flight delays in the late 1990's, the Single European Sky initiative was launched by the European Commission to reform European Air Traffic Management. The first SES legislative package (SES1) was drafted by the Commission in 2001 and adopted by the Parliament and Council in March 2004, entering into force a month later.

SES1 was fundamentally a prescriptive package. It established key principles such as the separation of service provision from regulation (hence the creation of National Supervisory Authorities), the certification and designation of service providers and the transposition of ICAO and EUROCONTROL<sup>1</sup> rules in to EU law. It also established the concept of Functional Airspace Blocks (FABs) requiring Member States to harmonise airspace in accordance with operational requirements rather than national boundaries.

In terms of technical modernisation, the interoperability (Regulation (EC) No 552/2004) enabled Implementing Rules (IRs) to be developed to support harmonised deployment. Early IRs were used to ensure common implementation dates for key infrastructure such as COTR rule<sup>2</sup> but there was no overarching plan or architecture for modernisation.

The SESAR programme was conceived by the industry in the widest sense, with the objective of developing a European ATM Master Plan that would enable modernisation of ATM through a partnership approach of all stakeholders. The ATM Master Plan was envisaged as the overarching plan for modernisation.

The Commission funded study on the creation of the SESAR JU considered the likely benefits to be (Steer Davies Gleave, 2005):

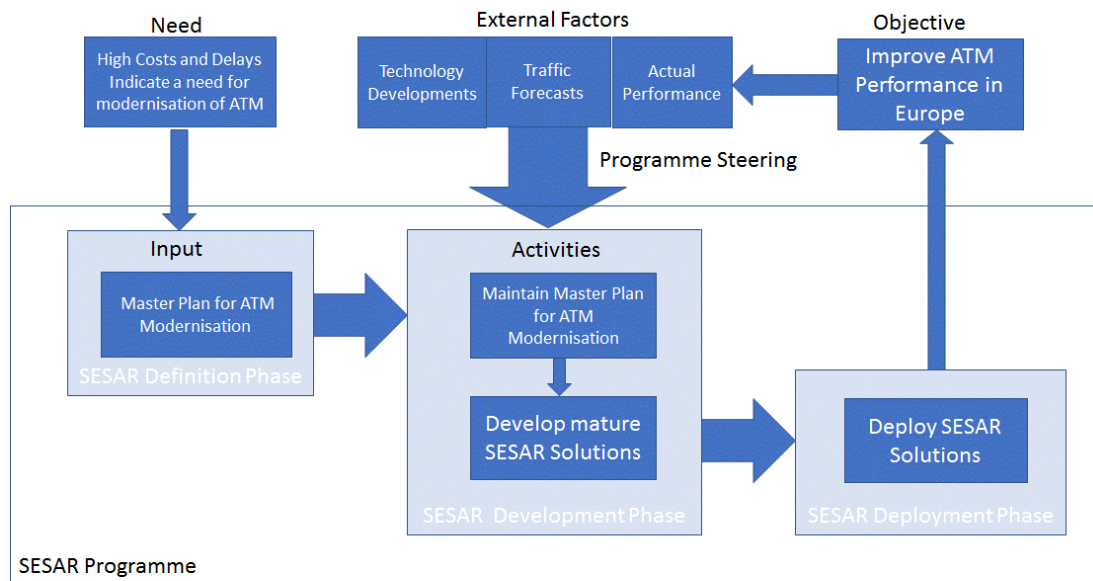
- Earlier implementation, and consequential benefits of new concepts and technologies;
- Potentially, a better phasing of projects, taking advantage of reduced implementation times and greater focus on high-priority projects;
- Lower expenditure on conventional system upgrades of legacy systems;
- Lower development costs – or “better value-added” development – due to a reduced number of parallel developments;
- Lower equipage costs for aircraft operators; and
- Competitive advantage for the European air transport industry.

The intervention logic is summarised in Figure 1 including the three phases of SESAR which are explained in further detail in the next section. It should be noted that the right-hand side of the diagram illustrates the ATM Modernisation Lifecycle that is now central to the SESAR project. This is described in more detail in Section 3.1.5.

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<sup>1</sup> The EUROCONTROL Safety Regulatory Requirement (see <http://www.eurocontrol.int/articles/src-publications>)

<sup>2</sup> Commission Regulation (EC) No 1032/2006 of 6 July 2006 laying down requirements for automatic systems for the exchange of flight data for the purpose of notification, coordination and transfer of flights between air traffic control units



SESAR forms part of the SES policy to transform the ATM Sector

**Figure 1. SESAR intervention logic.**

Whilst the core industry objective for SESAR was one Master Plan, agreed to and followed by all, the Commission also set performance objectives. In his speech at the launch event of the Definition Phase in November 2005, Vice President Jacques Barrot expressed the objectives of the SESAR programme as (SESAR Consortium, 2008):

“to achieve a future European Air Traffic Management (ATM) System for 2020 and beyond which can, relative to today's performance:

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

These objectives became known as the SES High Level Goals. They form an integral part of the first edition of the European ATM Master Plan (SESAR Consortium, 2008) and as such were adopted by the Council in March 2009 (Council Decision 2009/320/EC). Their evolution and the SESAR contribution to achieve them are central to understanding the effectiveness, coherence and added value of the SJU.

### **3.1.2. The three phases of SESAR**

The SESAR project consists of three distinct phases:

- Definition: Defined the need the modernisation of ATM and generated the first edition of the ATM Master Plan.
- Development: R&D Programme to develop “solutions” to achieve modernisation
- Deployment: Timely synchronised deployment of those solutions.

The original definition phase was initiated in 2005 as a €60 million 2-year programme co-financed by the European Commission and EUROCONTROL and managed by EUROCONTROL. It was performed by the Global Consortium consisting of 30 members and 20 subcontractors covering all ATM stakeholder groups: Air Navigation Service Providers (ANSPs), airports, airspace users and manufacturers.



Six main deliverables were produced that described the current performance and performance needs, an operational concept and architecture to meet those needs, a deployment sequence and master plan along with a work programme for the R&D required to refine the proposed concept, architecture and systems (See Table 1).

**Table 1. SESAR definition phase deliverables.**

Milestone 1 (D1)	Milestone 2 (D2)	Milestone 3 (D3)	Milestone 4 (D4)	Milestone 5 (D5)	Milestone 6 (D6)
Current Situation	Performance Needs	Concept of Operations	Deployment Sequence	ATM Master Plan	Work Programme
<ul style="list-style-type: none"> <li>• Capture of Current Situation with clear identification of Rationale</li> <li>• Strengths, Weaknesses, Deficiencies, Overview of Current Initiatives, etc.</li> <li>• Expectations for Future</li> </ul>	<ul style="list-style-type: none"> <li>• Outline Vision of Future Air Transport Industry &amp; Role of ATM</li> <li>• Performance Requirements for Future Network</li> <li>• Identification of “Best Practice” &amp; Principles upon which to Build</li> </ul>	<ul style="list-style-type: none"> <li>• Concept of Operations</li> <li>• Architecture for Future ATM System Network</li> <li>• Set of Enabling Technologies Identified</li> <li>• Outline of Total Cost &amp; Preliminary Assurance that Target is Viable</li> </ul>	<ul style="list-style-type: none"> <li>• Confirmation of Viability (Technical, Financial, Institutional, etc.)</li> <li>• Options for Deployment Sequence &amp; Recommended “Best” Approach</li> <li>• Definition of Deployment Packages (Transition from Legacy Systems/Framework)</li> </ul>	<ul style="list-style-type: none"> <li>• Detailed Plan of Actions which All Relevant Organisations need to undertake to Implement Changes</li> <li>• Inputs to Future Business Plans, R&amp;T/D Plans, Risk Assessment Regimes, Development of Future Management Processes, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Proposed Management Structure for SESAR Implementation Phase</li> <li>• Proposed Structured Lifecycle &amp; Methods to Support Implementation</li> <li>• Detailed Programme of Work for First 5 Years of Implementation Phase</li> </ul>

The deliverables of the definition phase provided the initial context for the work of the SESAR Joint Undertaking; but they also defined a concept of industrial partnership to drive harmonisation of European ATM through the adoption of a common concept and architecture. In particular, D5 was adopted as the first edition of the European ATM Master Plan (SESAR Consortium, 2008) and D6 (SESAR Consortium DLM-0710-001-02-00, 2008) which contained the first draft of the SESAR definition phase work programme.

### **3.1.3. The role of the SESAR Joint Undertaking**

The SESAR Joint Undertaking was established to “manage the activities of the development phase” of SESAR. The role is defined in Article 1.5 of SJU Basic Regulation (Council Regulation (EC) No 219/2007), see Text Box 1. In effect SJU has (at least) four distinct roles:

- Management of the SESAR Development Phase work programme as a Public-Private Partnership;
- Maintenance of the European ATM Master Plan;
- Supporting the global interoperability of ATM;
- Providing support to the European Commission and the European Parliament on technical issues relating to the SES (in recent years this has included Cybersecurity, Drones and Datalink as well as advice on the contents of the Pilot Common Project).

5. The aim of the Joint Undertaking shall be to ensure the modernisation of the European air traffic management system by coordinating and concentrating all relevant research and development efforts in the Community. It shall be responsible for the execution of the ATM Master Plan and in particular for carrying out the following tasks:

- organising and coordinating the activities of the development phase of the SESAR project, in accordance with the ATM Master Plan, resulting from the definition phase of the project managed by Eurocontrol, by combining and managing under a single structure public and private sector funding,
- ensuring the necessary funding for the activities of the development phase of the SESAR project in accordance with the ATM Master Plan,
- ensuring the involvement of the stakeholders of the air traffic management sector in Europe, in particular: air navigation service providers, airspace users, professional staff associations, airports, and manufacturing industry; as well as the relevant scientific institutions or the relevant scientific community,
- organising the technical work of research and development, validation and study, to be

**Text Box 1. Extract from SJU Basic Regulation (Council Regulation (EC) No 219/2007).**

Together, these roles emphasise the importance of the link between the work of the SJU and wider SES policy. SESAR is not just a R&D programme; it is a transformative programme for a critical sector in the European economy.

It is important to note that prior to the creation of the SJU, it had been envisaged that a single body would have responsibility for both the development and deployment phases. The SESAR Definition Phase referred to this as the “SESAR Performance Partnership”. However, as Article 171 of the Treaty establishing the European Union (Official Journal of the European Communities, 2002)<sup>3</sup> was used as legal basis for the creation of the SJU, the role was limited to the development phase – “*research, technological development and demonstration programmes*”. As will be discussed in the next section, another body – the SESAR Deployment Manager – has since been created to manage the Deployment Phase.

This legal basis and role of SESAR is important to the evaluation. The SJU is not a Joint Technology Initiative (JTI). JTIs were created under the FP7 and subsequently H2020 legislation to support the Lisbon Growth and Jobs Agenda (Council Decision 2006/971/EC) and have a research focus in that they aim to increase research in their respective fields.

The SJU is a policy oriented with the specific objective of supporting the modernisation of ATM in Europe. It was not set up as a JTI due to its specific policy-oriented activities (EC COM(2013) 494, 2013).

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<sup>3</sup> Pages 0033 - 0184

#### **3.1.4.      *SESAR and SES2***

The second package of the Single European Sky legislation (SES2), adopted in 2009, was a significant revision of SES which:

- Introduced Network Manager and the concept of Network Functions.
- Introduced a performance scheme to provide economic regulation of ANSPs (including setting of targets for safety, capacity, and environmental impact).
- Transformed Functional Airspace Blocks from an airspace issue to an operational one requiring Member States to optimise service provision within FABs.
- Provided a definition of Common Projects as the legal basis for “synchronised deployment” within the SESAR deployment phase. The SESAR deployment phase has subsequently been launched under the management of the SESAR Deployment Manager.

SES2 also strengthened the links between SESAR and the overall SES policy. Firstly, by inclusion of a recital requiring close coordination between SES and SESAR (see Text Box 2) and secondly through the introduction of links between the performance scheme and

(6) Council Regulation (EC) No 219/2007 of 27 February 2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR) calls for the development and implementation of an ATM Master Plan. The implementation of the ATM Master Plan requires regulatory measures to support the development, introduction and financing of new concepts and technologies. It should result in a system composed of fully harmonised and interoperable components, which guarantee high performance air transport activities in Europe. The schedule for implementation of the single European sky should take into consideration the timescale foreseen for the development and deployment phases of the SESAR programme as a part of the single European sky. Both processes should be closely coordinated.

the European ATM Master Plan.

***Text Box 2.Extract from SES2 regulation.***

Achievement of the High Level Goals requires implementation of all aspects of the SES legislation – including deployment of SESAR solutions but also institutional and organisational reform incentivised through the Performance Scheme. SES2 also strengthened the social dialogue to ensure that the human dimension is taken into account in achieving the necessary transformation. At the same time, the EASA system was strengthened to support the safety dimension.

#### **3.1.5.      *SESAR today***

The role of the SESAR programme, and therefore the requirements placed on the SJU have clearly evolved over time. At a policy level the main changes are:

- The economic crisis of 2008 profoundly affected the traffic levels in Europe. It is now projected that the doubling of traffic compared to 2005 forecast for 2020 will not occur until at least 2040.
- There is an increased awareness of the environmental impact of aviation. Sustainable growth of air transport requires both improved aircraft and fuels (the role of Clean Sky) but also efficient procedures (the role of SESAR).
- The Deployment Phase has been successfully launched. Deployment of the first Common project (the Pilot Common Project is underway under the management of the SESAR Deployment Manager (SDM)). This strengthens the interface between the Development and Deployment Phases of SESAR and increases the

importance of the Master Plan as a single reference for ATM modernisation in Europe and the likelihood of SESAR solutions being deployed.

- There is an increased focus on performance led development within the ATM sector. SESAR solutions therefore need to respond to both EU-wide and local performance needs.
- A number of significant technological issues have emerged (for example cyber-security, drones) that effect the required work of the SJU.

The evolution of SESAR during this period and the activation of the deployment phase has established an ATM modernisation lifecycle that ensures, through updates the European ATM Master Plan, that the SESAR project in general and the SJU work programme in particular is steered towards the actions necessary to develop and deploy the correct solutions to achieve the SES policy objectives.

The policy link for SESAR remains as crucial today as it ever was. The need for SESAR was reinforced in the Commission Transport White Paper published in 2011 (European Commission, 2011) and the subsequent implementation report published in 2016 (European Commission, SWD(2016)). The Commissions Aviation Strategy<sup>4</sup> published in December 2015 also recognises the importance of SESAR for achievement of wider air transport goals.

This new vision of the three SESAR phases as a lifecycle was expressed in the recitals of Regulation (EU) 721/2014 which extended the duration of the SESAR Joint Undertaking from 2016 to 2024, leading to two distinct phases of the SESAR development phase.

**Table 2. Phases of the SESAR Development Phase**

Phase	Dates	EC Contribution	Total Available Budget	Financial Rules
SESAR1	2008 - 2016	TEN-T: €350 M FP7: €350 M	€2.1 Bn	SJU (based on FP7)
SESAR2020	2015 - 2024	H2020: €585 M	€1.5 Bn	H2020

In December 2014, the SESAR Deployment Phase was launched by establishing the SESAR Deployment Manager<sup>5</sup> in accordance with (Commission Implementing Regulation (EU) No 409/2013) with the mandate to secure deployment of the Pilot Common Project (Commission Implementing Regulation (EU) No 716/2014).

The SESAR Programme consists of all three phases of SESAR and forms a continuous ATM modernisation lifecycle as illustrated in Figure 2.



**Figure 2: The SESAR ATM Modernisation Lifecycle<sup>6</sup>**

<sup>4</sup> [https://ec.europa.eu/transport/modes/air/aviation-strategy\\_en](https://ec.europa.eu/transport/modes/air/aviation-strategy_en)

<sup>5</sup> <http://www.sesardeploymentmanager.eu/>

<sup>6</sup> [https://ec.europa.eu/transport/modes/air/sesar\\_en](https://ec.europa.eu/transport/modes/air/sesar_en)

The SJU manages the R&D needed for the modernisation of ATM, culminating in mature SESAR solutions (at TRL 6). The mature SESAR solutions are published and can be taken up for deployment.

Core functionalities requiring synchronised deployment can be mandated using the provisions of Commission Implementing Regulation (EU) No 409/2013 and entrusted to SESAR Deployment Manager. The Connecting Europe Facility includes funds identified for deployment of core functionalities and additional funds for deployment of SESAR solutions with local benefits.

The objective of the deployment (both EU-wide and voluntary local) is to improve the ATM performance, and to contribute to the achievement of the SES High Level Goals. As both the development and deployment phase are progressing over time, the impact of the external factors is assessed periodically and taken into account in the updates to the European ATM Master Plan, thus steering the SESAR programme in order to remain relevant in the changing environment.

The external factors influencing the programme include the technology developments outside of the strict ATM environment, traffic demand and the actual performance of the European ATM system. The recent years have seen rapid developments in drones, cybersecurity issues, big data – all have been reflected in the Master Plan updates.

The urgency of deployment of some solutions depends on the need, which is created by the traffic demand. As traffic demand depends on many factors, and as the past decades have seen more than one slump in the demand, the traffic forecasts in Europe are regularly updated. EUROCONTROL's STATFOR<sup>7</sup> forecasts are used by different ATM stakeholders in their daily operations.

Of course, the actual performance of the system also influences the need for R&D and consequently its deployment. SES2 introduced the network manager function and performance scheme (including setting of targets for safety, capacity, and environmental impact), within its performance pillar. Thus, the actual operations are managed by the ANSPs and the Network Manager (NM) working together, and the performance of the system is assessed by the Performance Review Body (PRB). These assessments also help steer the SESAR programme.

### **3.2. Baseline**

This section describes the situation before SESAR in terms of:

- The ATM value chain in terms of the development of new products; and
- The modes of ATM research prior to SESAR.

The purpose in doing so to further explain the need for the SESAR programme and establish issues that SESAR was intended to address.

#### **3.2.1. ATM Value Chain**

Air Traffic Management is central to the provision of safe and efficient Air Transport. ATM is typically provided under monopoly conditions by national Air Navigation Service Providers (ANSPs). ANSPs were traditionally part of the Government, often with the same organisation providing regulatory functions (this is still the case in America, where the Federal Aviation Authority (FAA) is both regulator and service provider).

Over the last 20 years there has been a steady process of "corporatisation" of ANSPs. In most cases the ANSP is created as a standalone organisation fully funded by the collection of Air Navigation Charges from Airspace Users. These organisations typically

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<sup>7</sup> <http://www.eurocontrol.int/statfor>

remain under public ownership but there are examples where they are under private ownership (for example NATS and NavCanada).

Whilst en-route ATM is provided as a monopoly service, there have been a number of States who have decided to open airport Air Traffic Control (ATC) services to competition. The most mature market is in the UK, but Spain, Germany and Norway (amongst others) allow for some competition for ATM services.

This has led to two quite distinct markets for ATM products within Europe:

- A rather static market for en-route systems such as Flight Data Processors (FDP), Radar Data Processes (RDP) and Controller Work Positions. These systems tended to have a lifecycle of between 10 and 20 years.
- A more dynamic market for airport systems (Tower FDPs, airfield lighting systems, surface movement guidance and control systems).

For en-route systems manufacturers tended to develop new generations under contract to an ANSP. Each new system would be specified by the ANSP and developed as a bespoke system, often with proprietary interfaces. This led to limited development of products. As the market for airport ATC systems is several hundred airports across Europe rather than 40 or so en-route ANSPs there tended to be more innovation in airport systems.

### **3.2.2. ATM Research Prior to SESAR**

In 2005 air transport was experiencing significant year on year growth and a fear that delays would increase again if significant action was not taken to modernise and de-fragment European ATM. Significant R&D was being undertaken in Air Traffic Management. EUROCONTROL spent about €150-200 million a year on research and development (although some of this cost covers the planning and coordination of implementation) in the ATM sector; the Commission funding for ATM under the Fifth Framework Programme amounted to €20.8 million between 1998 and 2002, and was planned to support ATM by around €100 million over the 2002-2006 period; and the European Investment Bank also contributed €390 million to support ATM in Europe between 1999 and 2003 (Steer Davies Gleave, 2005).

The review of existing R&D by the SESAR definition phase identified 58 initiatives; including (SESAR Consortium DLT-0507-221-00-02, 2006):

- FP6 funded programmes including research on topics such as SWIM, A-SMGCS and CDM, which were to become central to the SESAR Development Phase work programme.
- EUROCONTROL research including the PHARE<sup>8</sup> which included research on 4D trajectory management, which formed the basis of the concept developed with the Definition Phase.
- National Programmes which fed into the procurement plans of ANSPs. In particular LFV in Sweden had a strong national programme.

The R&D tended to be conducted by research organisations and ANSPs, with limited involvement from airspace users and airport operators. A core issue at the time was application of Airborne Separation Assistance System (ASAS) within a Free Flight environment – including delegation of separation tasks to the cockpit and how this fitted in with the trajectory-based concepts. Without the creation of SESAR it is not clear how the completing issues would have been resolved.

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<sup>8</sup> [https://www.eurocontrol.int/phare/public/subsite\\_homepage/homepage.html](https://www.eurocontrol.int/phare/public/subsite_homepage/homepage.html)

### **3.2.3.        *Issues for SESAR***

The SESAR was intended therefore to address the following issues:

- R&D fragmentation: There was no overarching R&D strategy to ensure that solutions were developed to address specific performance needs or indeed that all options were considered and the best taken forward.
- Limited deployment: There was no coherent deployment plan that would ensure widespread adoption of new technology.
- Limited involvement: There was limited involvement from airspace users and airport operators (as the customers of ATM) in the definition of the R&D programmes.



## 4. EVALUATION QUESTIONS

This final evaluation of the SJU under SESAR1 focusses on the following aspects:

- **Effectiveness:** The progress towards meeting the objectives set, including how all parties in the PPPs live up to their financial and managerial responsibilities and keep an open non-discriminatory attitude towards a wide community of stakeholders.
- **Efficiency:** The extent to which the SJU was managed and operated efficiently.
- **Research Quality:** The extent to which the SJU enabled world-class research that helped Europe to establish a leadership position globally, and how it engaged with a wider constituency to open the research to the broader society.

In addition to the legal requirements and in order to allow meaningful comparison between the first and the second generation JUs, these additional aspects are addressed:

- **Openness and Transparency:** The extent to which the JUs keep an open non-discriminatory attitude towards a wide community of stakeholders and provide them with easy and effective access to information on the calls.

The above-mentioned main evaluation aspects are integrated in the overall evaluation framework (addressed under different evaluation questions).

Evaluation question 1: Background, objectives and relevance of the initiative (see Section 3)

The JUs represent the stepping-stone towards setting up PPPs in research at the European level. They bring together EU, national and private resources, know-how and research capabilities, with the aim of addressing major issues by sharing knowledge, achieving critical mass, scale and scope.

In this way, they help the EU to become a world leader in developing breakthrough technologies with high innovation potential. The public-private partnership is one of the FP7 implementation modalities where all involved partners commit to support the development and implementation of research and innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to addressing specific societal challenges. As a first step, the regulatory framework is analysed and context and background information concerning the setting up of the SJU is provided.

A summary of the situation before the approval and the set-up of the SJU is presented as well as a brief description of the initiative, its objectives and the problems it intended to solve.

The intervention logic of the SJU setup is presented, as well as the relevance of the SJU objectives and whether the objectives were consistent with the strategic context and with the challenges that had been identified.

### **Evaluation question 2: Implementation of the SJU** (see Section 6)

The analysis of the implementation of the SJU set by the (Council Regulation (EC) No 219/2007) is presented. Information about different participation patterns of European research actors and about the distribution of funds among beneficiaries provides important information in order to assess if the SJU has reached the main research actors in Europe and highlight the main research and structural trends.

### **Evaluation question 3: Effectiveness of implementation and main achievements** (see Sections 7.1 and 7.2.2)

Evaluation of whether the establishment of the SJU and its actual operations are in line with the Council Regulation and whether they represent a workable framework for achieving the SJU's objectives as set out in Article 1(5) of the SJU Regulation is addressed. The overall approach in answering this evaluation question focuses on assessing the link between the SJU's mandate/responsibilities and objectives set in the Article 1(5) of its legal basis, its governance and the actual activities and performance.

- *SJU's mission and governance.* The legal basis of SJU is reviewed to analyse and assess the SJU's progress towards meeting the objectives set for in Article 1(5) of



its basic act, including how all parties in the PPP live up to their financial and managerial responsibilities and keep an open non-discriminatory attitude towards a wide community of stakeholders.

- *Operational Effectiveness.* Assessment of whether the establishment of the SJU and its actual operations are in line with the Council Regulation establishing it and whether they represent a workable framework for achieving the SJU's objectives as set out in Article 1(5) of the SJU Regulation is presented.
- *Direct achievements.* Direct achievements focus on concrete outcomes and deliverables of the SJU's interventions. Information about different forms of direct achievements of the SJU funded research projects is crucial to assess whether the SJU reached its research goals. It also represents the core of an evidence-based analysis of funded projects. Notably, the extent to which scientific outputs produced by the SJU's interventions generated socio-economic effects and other impacts and helped to tackle relevant societal challenges is addressed and presented.

#### **Evaluation question 4: – Operational efficiency** (see Section 7.2.3)

Operational efficiency considers the relationship between the resources used and changes generated, taking into account the operational efficiency indicators.

#### **Evaluation question 5 - European added value** (see Section 7.3)

The EU-added value relates to changes that can be reasonably attributed to an EU intervention, rather than other factors, compared to what could be achieved by the Member States alone at national/or regional levels.

Among others this assessment covers the SJU's ability to leverage additional investments in research and innovation. Where the SJU's ability to attract additional finance and multiply its own, mainly EU resources, including additional activities, i.e., activities of the industry outside the work programme of the SJU that nevertheless are in support of its objectives is considered to be leverage effect. The leverage effect is defined as the total amount of funds leveraged through an Article 187 initiative, including additional activities, divided by the respective EU contribution to this initiative.

#### **Evaluation Question 6 – Coherence** (see Section 7.4)

Taking into account the objectives of the SJU, an assessment of how well the intervention worked: i) internally within the SJU (ability to coordinate different viewpoints and strategies within the railway sector), ii) within FP7 and iii) with other EU policies and interventions; is presented.

#### **Evaluation question 7 – Synthesis, conclusions and recommendations** (see Sections 8 and 9)

Synthesis of the work done under the previous tasks is presented, conclusions drawn and recommendations provided. The judgements are based on the evidence and analysis available, and are as specific as possible.

## **5. METHOD/PROCESS FOLLOWED**

### **5.1. Process/Methodology**

#### **5.1.1. Evaluation of the Transport Joint Undertakings**

The European Commission assembled a team on nine experts under Chairmanship of Michael Doms to perform evaluations of the three Transport Joint Undertakings (TJUs) namely: SESAR, Clean Sky and Shift2Rail. The expert team met on four occasions (including 2 steering group meetings with the European Commission) to ensure a consistent approach was taken to the evaluations. However, the work of the three teams was largely independent of each other.

#### **5.1.2. Evaluation of SESAR Joint Undertaking**

The SESAR evaluation was performed by Dr Tatjana Bolic and Mr Paul Ravenhill supported by Mr Helge Pfeiffer (who additionally worked on the Clean Sky evaluations) with additional material from Heather Allen on general policy and Transport Issues.

The evaluation was conducted between 17<sup>th</sup> January and 30<sup>th</sup> June 2017 and was based solely on expert judgement and the information sources described below and in further detail in the Annexes to this report. The structure of this report was determined by European Commission.

### **5.2. Sources of information**

#### **5.2.1. Documentation**

Detailed desk study of relevant documentation was performed. Material consulted include:

- Legislation relating to SES and SESAR.
- SJU Documentation
- Annual Reports
- Single Planning Documents
- Audit Reports
- External Reports

A full list of the material consulted is presented at Annex D.

#### **5.2.2. Interviews**

A number of face to face and telephone interviews were conducted with:

- European Commission
- SESAR Joint Undertaking Staff
- SESAR Members
- Industry Stakeholders.
- Members of the European Parliament

In total, 30 interviews were conducted between February and June 2017. A full list of interviews is presented in Annex E.

#### **5.2.3. Public Survey**

An on-line public survey was conducted between the 8<sup>th</sup> December 2016 and 10<sup>th</sup> March 2017. The questions were developed by the European Commission before the Evaluation Team initiated their work. The survey covered all nine Joint Undertakings operating under Horizon 2020. There were 68 responses for SESAR JU – some of the answers are pertinent to SESAR1. The results are presented in Annex F.

#### **5.2.4. Beneficiary Survey**

A survey prepared by European Commission was sent to the 179 organisations that either participated in or applied for funds for SESAR1 and SESAR20202. There were 49 responses. The main results are presented in Annex G.

#### **5.3. Limitations – robustness of findings**

In general terms, the experts considered that the data collected to be sufficient for the tasks and had no reasons to doubt the robustness of their findings based on this study and data.

It should however also be noted that the evaluation questions are often based on terminology from Horizon 2020 and use KPIs defined in the Horizon 2020 regulation. As described in Section 6, SESAR1 was operated according to the SESAR Financial Regulation and rules and some data is not available in the required form. This is particularly true for operational efficiency.

## 6. IMPLEMENTATION OF SESAR JOINT UNDERTAKING

### 6.1. Membership of the SJU

#### 6.1.1. Founding Members

Article 1 (1) of the Statutes of the SJU<sup>9</sup> defines the founding members of the SJU as the European Commission and EUROCONTROL.

EUROCONTROL is an inter-government agency responsible for the safety of air navigation in Europe with 41 Member States<sup>10</sup>. EUROCONTROL is an important contributor European ATM; EUROCONTROL roles include being Network Manager, provision of ATM at the Maastricht Upper Area Control Centre and provider of considerable ATM R&D expertise through the EUROCONTROL Experimental Centre.

#### 6.1.2. Full Members

Full Members were selected by an open call launched on the 27<sup>th</sup> June 2007 and completed on the 12<sup>th</sup> June 2008 when the Membership Agreements were signed<sup>11</sup>. The 15 selected members are listed in Table 3. The table also provides an indication of their contribution to the SESAR1 programme as the value of work conducted (including EU and Member contribution until the end of 2015).

**Table 3. Members of the SJU**

Member	Consortia Members	Sector	Country	Contribution
AENA		ANSP	Spain	€45,923,587
DFS		ANSP	Germany	€58,503,780
DSNA		ANSP	France	€56,498,236
ENAV		ANSP	Italy	€49,495,325
NORACON	AustroControl	ANSP	Austria	€3,962,387
	Avinor	ANSP	Norway	€5,293,191
	Finavia	ANSP	Finland	€817,623
	IAA	ANSO	Ireland	€1,493,902
	Isavia	ANSP	Iceland	€178,022
	EANS	ANSP	Estonia	€840,659
	LFV	ANSP	Sweden	€28,635,817
	Naviar	ANSP	Denmark	€3,068,399
NATS		ANSP	UK	€43,538,701
SEAC	Heathrow Airport	Airport	UK	€291,669
	Munich Airport	Airport	Germany	€2,276,403
	Frankfurt Airport	Airport	Germany	€2,821,973
	Schiphol Airport	Airport	Netherlands	€1,494,154
	Aéroports de Paris	Airport	France	€2,404,662
	Zürich Airport	Airport	Switzerland	€2,267,906
FREQUENTIS		Manufacturer	Austria	€24,670,950
INDRA		Manufacturer	Spain	€109,680,983
NATMIG	SAAB	Manufacturer	Sweden	€4,803,614
	SINTEF	Manufacturer	Norway	€15,300,615
	Northop Gruman	Manufacturer	USA	€3,689,993
	Indra	Manufacturer	Spain	€6,846,469
	Airtel ATN	Manufacturer	Ireland	€473,641

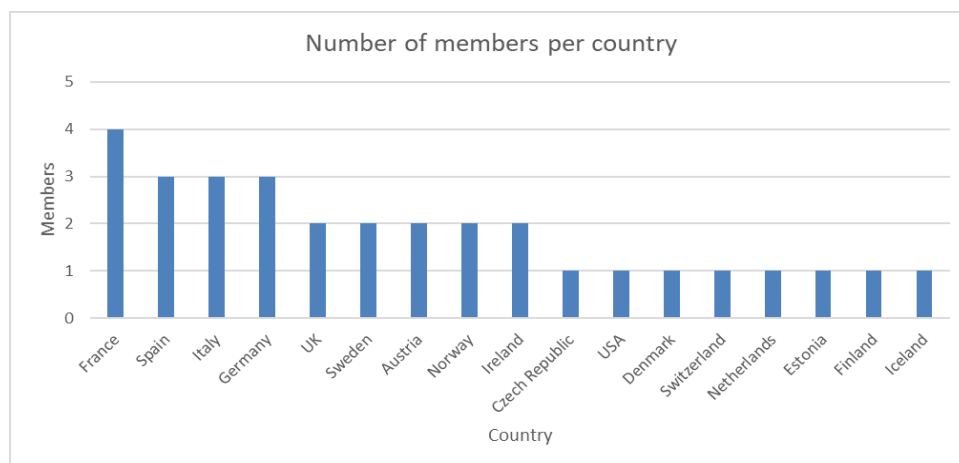
<sup>9</sup> Annex to Council Regulation (EC) 219/2007

<sup>10</sup> [www.eurocontrol.int](http://www.eurocontrol.int)

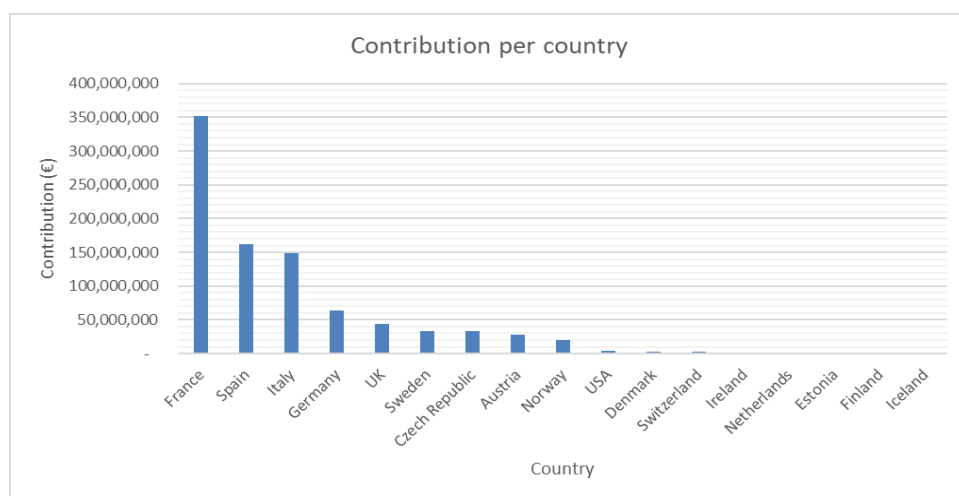
<sup>11</sup> A full timeline of the membership process is presented as appendix 6 of the initial mid-term evaluation (COWI, 2010).

Member	Consortia Members	Sector	Country	Contribution
SELEX		Manufacturer	Italy	€71,891,564
THALES		Manufacturer	France	€195,089,192
AIRBUS		Manufacturer	France	€98,128,777
ALENIA		Manufacturer	Italy	€27,440,080
HONEYWELL		Manufacturer	Czech Republic	€32,856,312

Figure 3 below shows the geographical distribution of SJU members, while Figure 4 depicts the contribution to SESAR per country.



**Figure 3. Geographical distribution of SJU members.**



**Figure 4. Contribution by SJU members, per country.**

### 6.1.3. Associate Members

The SJU established two forms of associate Members:

- Associate Partner of an SJU Member – organisations that full Members felt would be beneficial to achieving their own contribution to SESAR and who were prepared to make a financial contribution (as opposed to sub-contractors).
- Associate Partner of the SJU – organisations selected by the SJU to “fill gaps” in the perceived capability of the membership.

Associate Partner of an SJU Member were selected by Members and endorsed by the Administration Board in 2010 (ADB(D)-08-2010). The selected associated members are listed in Table 4.

**Table 4. Associate Members to an SJU Member**

Member	Sponsor	Sector	Country	Contribution
NAV Portugal	AENA	ANSP	Portugal	€494,948
AVTECH	Airbus	Manufactur	Sweden	€2,730,451
Boeing	Airbus	Manufactur	USA	€1,420,339
Consortium LNVL	DFS, DSNA, ENAV	ANSP	Netherlands	€436,840
SkyGuide	DFS, DSNA	ANSP	Switzerland	€689,702
ONDA	DSNA	Airports	Morocco	-
Belgocontrol	DSNA	ANSP	Belgium	€670,854
Lockheed Martin	INDRA	Manufactur	USA	€89,487
PANSA	INDRA	ANSP	Poland	-
NATS Services	NATS EN-route	ANSP	UK	€64,714
Milan Airport	SELEX	Airport	Italy	€150,282
THALES Australia	THALES	Manufactur	Australia	€3,969,713
THALES Raytheon Systems	THALES	Manufactur	UK	€220,733

Associate Partners of the SJU were selected by an open call (ref. SJU/LC/0055-CFP (OJ C 76, 10.3.2011, p. 15)) issued on 1<sup>st</sup> February 2011. The call was exclusively addressed to SMEs, research organisations, universities, and institutes of higher education. The call for proposals was divided into six lots:

- Lot 1 – Information management;
- Lot 2 – Network & airport collaboration;
- Lot 3 – Technical service management;
- Lot 4 – Airborne & CNS systems;
- Lot 5 – Modelling support to validation;
- Lot 6 – UAV/UAS integration in SESAR.

Following the assessment of the proposals and the endorsement of the SJU Executive Director's recommendation by the Administrative Board on 1<sup>st</sup> July 2011, Framework Partnership Agreements were awarded exclusively for lots 1, 2, 4, 5 and 6 to the two entities having received the highest scores for each of these lots. The award was confirmed by the Administrative Board (ADB(D)-04-2011). No award was made for Lot 3. The associate members are listed in Table 5.

**Table 5. Associate members to the SJU.**

Consortia	Members	Type	Country
Mosia (Lot 1)	SINTEF	Research Org	Norway
	Snowflake Software	SME	UK
	Open Geospatial Consortium (OGCE)	SME	Germany
	No Magic Europe UAB	SME	Italy
	Institute for Geoinformatics (IfGI)	University	Germany
	Westfälische Wilhelms-Universität Münster	University	Germany
	International Geospatial Services Instit	SME	Germany
	Envitia	SME	UK
	Carmenta Aktiebolag	SME	Sweden
	MEKON AIS Ltd	SME	Scotland
AT-One (Lot 1 and 4)	DLR	Research Org	Germany
	NLR	Research Org	Netherlands
Optromise (Lot 2)	The University of Nottingham	University	UK
	University of Southampton	University	UK
	Institutt for energiteknikk Stiftelsen	SME	Norway
	SINTEF	Research Org	Norway
ACCSES (Lot 2)	Nommon	SME	Spain
	ALG-Europraxis	SME	Spain
	INSISOC	University	Spain
	University of Trieste	University	Italy
MAGNITUDE (Lot 4)	Becker Elektronik Polska (BEP)	SME	Poland
	Telerad	SME	France
	ENAC (Ecole Nationale de l'Aviation Civile)	University	France
	ONERA/	Research Org	France
	CIRA - Centro Italiano Ricerche Aerospaziali	Research Org	Italy
	INTA	Research Org	Spain
	Helileo (HLO)	SME	France
	M3 Systems (M3S)	SME	France
	Inster Instalaciones	SME	Spain
	Altys Technologies	SME	France
	AVTECH Sweden	SME	Sweden
	Brightline Avionics GmbH (BLA)	SME	Germany
	Becker Flugfunkwerk GmbH	SME	Germany
INNOVATE (Lot 5)	Instituto Nacional de Técnica Aeroespacia	Research Org	Spain
	ONERA	Research Org	France
	AVTECH Sweden	SME	Sweden
	The University Court of the University of Aberdeen (UNIABDN)	University	Scotland
	The University of Edinburgh (UEDIN)	University	Scotland
	Universita' Degli Studi di Trento (UNITN)	University	Italy

Consortia	Members	Type	Country
VERTAS (Lot 5)	Deep Blue Srl (DBL)	SME	Italy
	AERTEC Ingenieria y Desarrollos	SME	Spain
	ISA Software Ltd	SME	France
	Think Research Ltd	SME	UK
ATM Fusion (Lot 6)	AVTECH Sweden	SME	Sweden
	BME	University	Hungary
	Deep Blue	SME	Italy
	ENAC - Ecole Nationale d'Aviation Civile	University	France
	Institutul National de Cercetari (INCAS)	Research Org	Romania
	INTA	Research Org	Spain
	ONERA	Research Org	France

Although Associate Members of the SJU represented 60 additional members including SME and universities very little work was placed with them.

## 6.2. Budget and Final Outcome

The headline figure of SESAR1 was €2.1Bn comprising equal contribution from the EU, EUROCONTROL and the industrial partners.

**Table 6. SESAR1 budget.**

Source of funding	Budget	Final
EU European Commission, FP7 (€350 M)	€700 M	€700 M
EU - Trans-European Transport Network Programme (€350 M)		
EUROCONTROL	€700 M	€670 M
Industry Partners	€700 M	€584 M
Total	€2100 M	€1900 M

Industrial Partners were co-funded at a fixed rate of 50% of actual costs and paid a 5% cash contribution to the running costs of the SJU. Membership is discussed in the next section. The final outcome is based on SJU estimates; final figures will not be available until the end of 2017.

## 6.3. The SESAR1 Work Programme

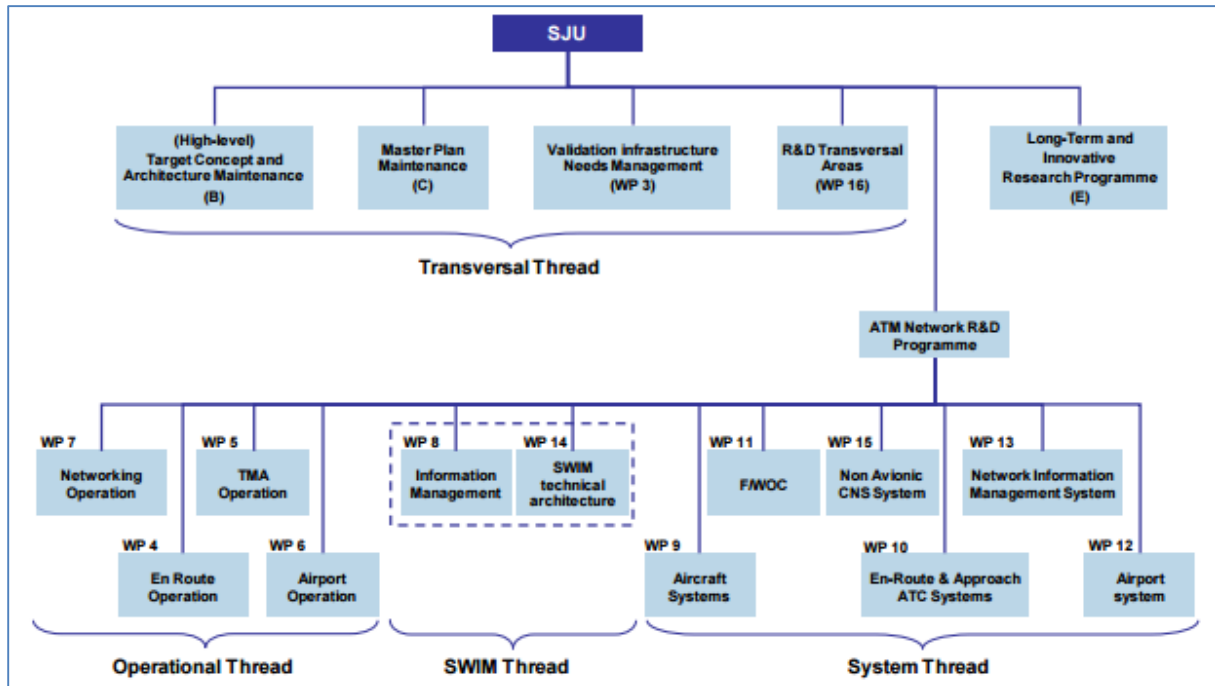
A total of 409 projects and demonstration activities were conducted in SESAR1 under the FP7 and TEN-T Framework programmes. This included:

- 322 Industrial Research and validation projects conducted by the members using the BAFO process,
- 45 Exploratory research projects (selected by open tender). Conducted as WP E these were long term and innovative research projects related to the typical scope of FP7 projects,
- 42 Demonstration activities (selected by open tender).



### 6.3.1. Industrial Research and Validation Projects

The core work programme (see Figure 5) was designed in the SESAR definition Phase around four key threads: Operational, System, System Wide Information Management (SWIM) and Transversal (SESAR Consortium DLM-0710-001-02-00, 2008). The main work packages are described in Annex B.



**Figure 5. SESAR Programme (source (SJU, 2014a))**

The 322 industrial research projects were conducted by the SJU Members based on the “Best and Final Offer” (BAFO) process. In total, there were three BAFOs for SESAR1 as summarised in Table 7.

**Table 7: Summary of the BAFO Process<sup>12</sup>**

BAFO	Timeline	Scope	Approx. Projects	EU Funding Committed
BAFO1	Dec 2008 to Mar 2009	<ul style="list-style-type: none"> <li>WPB (Target Concept and Architecture)</li> <li>WP3 (Validation Infrastructure),</li> <li>WP4 (En-Route Operations),</li> <li>WP5 (TMA operations),</li> <li>WP6 (Airport Operations),</li> <li>WP8 (Information management),</li> <li>WP9 (Aircraft),</li> <li>WP10 (En-Route &amp; Approach ATC Systems),</li> <li>WP12 (Airport Systems),</li> <li>WP14 (SWIM Technical Architecture),</li> <li>WP15 (Non Avionic CNS System).</li> </ul>	~200	~€500M
BAFO2	July 2009 to Dec 2009	<ul style="list-style-type: none"> <li>WP C (Master Plan Maintenance),</li> <li>WP 7 (Network Operations),</li> <li>WP 13 (Network Information Management System)</li> </ul>	~100	~125

<sup>12</sup> Derived from SJU Annual Activity Report 2009 (SJU, 2010) and SJU Annual Activity Report 2013 (SJU, 2014)

BAFO	Timeline	Scope	Approx. Projects	EU Funding Committed
		<ul style="list-style-type: none"> <li>• WP 16 (R&amp;D Transversal Areas)</li> <li>• 9.49 (Airborne Architecture and Avionics Interoperability Roadmap)</li> <li>• 46 projects and Sub-Work Packages not allocated in IBAFO 1</li> </ul>		
BAFO3	May 2013 to Dec 2013	Reallocation of funds to priorities stemming from update to the ATM Master Plan including: <ul style="list-style-type: none"> <li>• P15.01.07 – “CNS System of System • Definition”</li> <li>• P15.04.02 – “Integrated Surveillance Sensor</li> <li>• P15.04.06 – “Improved 1090 MHz ADS-B Ground Station capability &amp; Security”</li> <li>• P15.02.05 – “I4D Trajectory Exchange using SATCOM IRIS precursor”</li> </ul>	12	Mostly Reallocation

***The SJU experienced difficulty in managing the execution of more than 300 projects due to the large number of interdependencies between projects. A single project could be dependent on the outputs of many other projects often from several WPs. The principle method used to group projects during SESAR1 was the operation focus areas (OFA) which fundamentally grouped the projects delivering performance improvements in specific areas. The 31 OFAs are listed in***

Table 8 along with the level of investment in SESAR1.

**Table 8: Budget per OFA**

Operational Focus Area	R&D investment
LVPs using GBAS	€51.288.749
Pilot enhanced vision	€10.097.791
Airport safety nets	€33.501.191
Enhanced Runway Throughput	€58.229.089
Optimised 2D/3D Routes	€18.063.394
Free Routing	€61.412.494
Business and Mission Trajectory	€32.254.709
ASAS Spacing	€26.444.041
ATSA-ITP	€7.876.950
ASEP	€14.857.108
Ground Based Separation Provision in En Route	€32.688.151
Ground Based Separation Provision in the TMA	€28.331.893
Enhanced Ground Based Safety Nets	€8.154.975
Enhanced ACAS Operations	€9.787.250
Integrated Arrival/Departure Management at Airports	€21.563.069
Enhanced Arrival & Departure Management in TMA and En Route	€62.074.182
Integrated Surface Management	€50.691.364
Airport Operations Management	€41.938.689
Airspace Management and AFUA	€8.591.148
Dynamic Airspace Configurations	€8.980.336
Enhanced ATFCM processes	€28.633.262
UDPP	€13.565.056
Network Operations Planning	€16.701.340
CWP Airport	€27.138.732

Operational Focus Area	R&D investment
CWP En Route and TMA	€10.178.098
Remote Tower	€20.799.502
Communication	€46.473.646
Navigation	€13.554.334
Surveillance	€16.915.362
SWIM	€53.849.627
AIM/MET	€15.831.098
Trajectory Management Framework	€55.765.465
<b>Total</b>	<b>€906.232.094</b>

However, to communicate the results of SESAR to the wider community, the SJU and Membership developed the concept of "Solution". The SESAR solutions are *"new or improved operational procedures or technologies that aim to contribute to the modernisation of the European and global ATM system"* (SJU, 2017).

During SESAR1, 63 solutions were developed as summarised in Table 9. Further details are provided in Annex C. There are a further 54 Solutions that are considered not mature (in V1 or V2, which is lower than TRL6), which are expected to reach maturity under SESAR 2020.

**Table 9. SESAR solutions by category, and the budget spent (source: (SJU, 2016)).**

Solution category	Number of solutions	Number of solutions for PCP	Percent of total budget
High performing airports	21	6	28%
Advanced air traffic services	21	6	32%
Optimised ATM Network Management	8	6	24%
Enabling aviation infrastructure	13	5	17%

Out of 63 Solutions, 23 are related to the Pilot Common Project (Commission Implementing Regulation (EU) No 716/2014, 2014). These solutions have a mandate for deployment as described in Section 3.1.5.

### **6.3.1. Work package E Research projects - Exploratory Research**

During SESAR1, the SJU organised two calls for Exploratory Research projects resulting in 42 projects with grants totalling €1.6million (with an average grant size of €670k).

**Table 10. WP E projects.**

Project name	Lead Organisation	Lead Country	Lead Organisation Sector	Total Project Cost (€)	SJU Funding (%)
SUPEROPT	UNIVERSITY OF BRISTOL	UK	University	158.000	100%
NEWO	ISDEFE	Spain	Research Org	265.000	100%
STREAM	ADVANCED LOGISTICS GROUP	Spain	Research Org	453.000	100%
ONBOARD	GMV	Spain	Research Org	411.000	100%
ASHICS	UNIVERSITY OF YORK	UK	University	294.000	100%
POEM	UNIVERSITY OF WESTMINSTER	UK	University	371.000	100%

Project name	Lead Organisation	Lead Country	Lead Organisation Sector	Total Project Cost (€)	SJU Funding (%)
TESA	LONDON IMPERIAL COLLEGE	UK	University	285.000	100%
MUFASA	LOCHKEED MARTIN UK	UK	Ground Industry	639.000	100%
ADAGR & NEWO	ISDEFE	Spain	Research Org	625.000	100%
MAREA	NLR	Netherlands	Research Org	650.000	100%
C-SHARE	TECHNICAL UNIVERSITY DELFT	Netherlands	University	842.000	100%
COMPASS	THALES INFORMATION SYSTEMS	Belgium	Ground Industry	737.000	100%
ALIAS	EUI EUROPEAN UNIVERSITY INSTITUTE	Italy	University	686.000	100%
CASSIOPEA	INNAXIS	Spain	Research Org	682.000	100%
UTOPIA	TECHNICAL UNIVERSITY DRESDEN	Germany	University	962.000	100%
ZeFMaP	SINTEF	Austria	Ground Industry	876.000	100%
SPAD	DEEP BLUE	Italy	Research Org	730.000	100%
ELSA	DEEP BLUE	Italy	Research Org	679.000	100%
ROBUSTATM	FRIEDRICH-ALEXANDER UNIVERSITY ERLANGEN-NUREMBERG	Austria	Research Org	673.000	86%
AGATHA	ALTYS	France	Research Org	727.000	83%
SAFECORAM	CIRA	Italy	Research Org	372.000	75%
NINA	DEEP BLUE	Italy	Research Org	674.000	89%
ALIAS II	DEEP BLUE	Italy	Research Org	690.000	87%
MOTA	ENAC	France	Research Org	768.000	73%
6TH SENSE	FRAUNHOFER AUSTRIA	Austria	Research Org	583.000	64%
FLITE & TESA	LONDON IMPERIAL COLLEGE	UK	University	666.000	86%
SECUREDATACLOUD	INNAXIS	Spain	Research Org	760.000	78%
TREE	ISDEFE	Spain	Research Org	674.000	66%
ACCESS	NOMMON SOLUTIONS AND TECHNOLOGIES	Spain	Research Org	787.000	73%
SCALES	SINTEF	Norway	Research Org	799.000	75%
ACCHANGE	TRANSPORT & MOBILITY LEUVEN	Belgium	Ground Industry	760.000	79%
EMFASE	UNIVERSITY TRENTO	Italy	University	657.000	85%
SATURN	UNIVERSITY TRIESTE	Italy	University	594.000	100%
ERAINT	TECHNICAL UNIVERSITY OF CATALONIA - BARCELONA TECH	Spain	University	622.000	80%
COMPLEXITY COSTS & POEM	UNIVERSITY OF WESTMINSTER	UK	University	704.000	84%
PROGA	NLR	Netherlands	Research Org	661.000	96%

Project name	Lead Organisation	Lead Country	Lead Organisation Sector	Total Project Cost (€)	SJU Funding (%)
AEROGAME	NLR	Netherlands	Research Org	780.000	75%
ACF	NLR	Netherlands	Research Org	656.000	81%
EMERGIA	NLR	Netherlands	Research Org	400.000	75%
IMET	NLR	Netherlands	Research Org	581.000	75%

### 6.3.2. Demonstration Projects

During SESAR1, the SJU organised 5 calls for demonstration projects resulting in 66 projects with grants totalling €94million (with an average grant size of €1.4million):

- Three calls were launched to support the Atlantic Interoperability Initiative to Reduce Emissions (AIRE), which was a joint venture with the USA to integrated flight trials and demonstrations validating solutions for the reduction of CO2 emissions for surface, terminal and oceanic flight operations.
- Large Scale Demonstrations were designed to support validation of the core programme by providing large scale flight trials of developed solutions.
- Remotely Piloted Aircraft System (RPAS) Demonstrations were designed in investigate the integration of Unmanned Air Vehicles (UAVs) into non-segregated and controlled airspace.

**Table 11. AIRE projects.**

Project	Lead Organisation	Country	Organisation Sector	Total Project Cost (€)	SJU Fund (%)
Ground movements	AEROPORTS DE PARIS	France	Airport	238.668	52%
MINT	AVTECH	Sweden	Air Industry	200.000	50%
North Atlantic cruise climb lateral deviation and Mach number flight trials demonstration project	NAV Portugal	Portugal	ANSP	200.000	50%
Reduction of emissions on the North Atlantic by the implementation of ADS-B	ISAVIA	Iceland	ANSP	200.000	50%
RETACDA	INECO	Spain	Research Organisation	212.800	47%
Terminal Operations	DSNA	France	ANSP	220.000	51%
Airport CDM Project in Vienna	LUFTHANSA AVIATION GROUP	Germany	Airspace User	282.147	50%
Greener airports operations under adverse conditions	DSNA	France	ANSP	273.500	50%
B3 SESAR JU project	BRUSSELS AIRLINES	Belgium	Airspace User	300.000	50%
Down Wind Optimization	DSNA	France	ANSP	220.000	50%
Flight Trials for less CO2 emission during transition from en-route to final approach in a multi airport environment	LUFTHANSA	Germany	Airspace User	221.850	50%

Project	Lead Organisation	Country	Organisation Sector	Total Project Cost (€)	SJU Fund (%)
REACT-CR Reduction of Emissions Using CDAs in TMA in Czech Republic	PILDO	Spain	Research Organisation	269.139	50%
Reduction of Emissions in Terminal Areas (TMA) using Continuous Descent Approaches (CDA) - 2	INECO	Spain	ANSP	300.000	50%
DORIS	NAV PORTUGAL	Spain	ANSP	290.000	50%
ONATAP	NAV PORTUGAL	Spain	ANSP	120.000	50%
Reduced Longitudinal Separation in the North Atlantic	NATS	UK	ANSP	267.000	50%
ENGAGE Corridor	NATS	UK	ANSP	297.950	50%
A380 Transatlantic Green Flights	AIRBUS	France	Air Industry	394.000	50%
Green connection	LFV	Sweden	ANSP	400.000	50%
Green Shuttle	DSNA	France	ANSP	320.000	50%
Greener Wave	LUFTHANSA AVIATION GROUP	Germany	Airspace User	255.620	50%
Trajectory based night time CDA's at Schiphol Airport	LVNL	Netherlands	ANSP	388.247	50%
Transatlantic Green Flight	DSNA	France	ANSP	324.000	50%
VINGA	LFV	Sweden	ANSP	389.000	50%
AIRE III - Lot 1	PILDO	Spain	Research Organisation	238.200	50%
ENGAGE Phase II	NATS	UK	ANSP	552.928	50%
CANARIAS	QUOVADIS	France	Air Industry	512.000	50%
AMBER	AIR BALTIC CORPORATION AS	Latvia	Airspace User	264.000	50%
SMART	NAV Portugal	Portugal	ANSP	496.800	50%
SATISFIED	INECO	Spain	Research Org	500.000	50%
MAGGO	NAV Portugal	Portugal	ANSP	320.000	50%
OPTA-IN	INECO	Spain	Research Org	440.000	50%
WEE-FREE	AIR FRANCE	France	Airspace User	498.800	50%

**Table 12. Demonstration projects.**

Project	Lead Organisation	Country	Organisation Sector	Total Project Cost (€)	SJU Funding (%)
Free Solutions	ENAV	Italy	ANSP	5.333.000	50%
i-Stream	DSNA	France	ANSP	5.946.110	50%
ODP	DFS	Germany	ANSP	4.126.989	50%
Pegase	AIRBUS	France	Air Industry	2.107.162	50%
Toplink-L1	THALES	France	Ground Industry	6.154.167	50%

Augmented Approaches to Land	NETJETS EUROPE	Portugal	Airspace User	7.624.916	50%
Budapest 2.0	PILDO	Spain	Research Organisation	2.468.268	50%
E-CRA	AIRBUS	France	Air Industry	2.158.200	50%
EVA	NATS	UK	ANSP	1.098.484	50%
PROuD	ENAV	Italy	ANSP	1.455.260	50%
RACoon	ENAV	Ireland	ANSP	6.563.584	50%
Remote Towers	IAA	France	ANSP	2.034.754	50%
RISE	AIRBUS	Netherlands	Air Industry	3.320.806	50%
RTO	LVNL	France	ANSP	4.736.152	50%
Toplink - L2	THALES		Ground Industry	1.259.876	50%
AFD	ENAV	Italy	ANSP	2.797.975	50%
D-FLEX	AIR FRANCE	France	Airspace User	1.497.870	50%
FAIRSTREAM	DSNA	France	ANSP	1.799.200	50%
ICATS	INDRA	Spain	Ground Industry	2.269.966	50%
NASCIO	PILDO	Spain	Research Org	1.234.462	50%
NEWBRIDGE	NORACON (LFV)	Sweden	ANSP	2.518.000	30%
TOPFLIGHT	ASTRIUM SAT (NATS)	France	Air Industry	1.798.315	50%
TOPMET	THALES AIR SYSTEMS	France	Ground Industry	1.836.121	50%
FRAMak	DFS DEUTSCHE FLUGSICHERUNG GMBH	Germany	ANSP	3.508.148	30%

**Table 13. RPAS demonstration projects.**

Project	Lead Organisation	Country	Organisation Sector	Total estimated project cost (€)	SJU Funding (%)
IRICA	NLR	Netherlands	Research Organisation	1.000.000	50%
ARIADNA	INDRA	Spain	Ground Industry	899.110	50%
CLAIRE	THALES	France	Ground Industry	1.185.601	42%
DEMORPAS	ISDEFE	Spain	Research Organisation	799.997	50%
INSuRE	ENAV (IDS)	Italy	ANSP	824.238	50%
MedALE	ALENIA	Italy	Air Industry	1.000.000	50%
ODREA	Rockwell Collins France	France	Air Industry	1.024.951	49%
RAID	CIRA	Italy	Research Organisation	900.000	50%
TEMPAERIS	DSNA	France	ANSP	992.570	50%



## **7. ANSWERS TO THE EVALUATION QUESTIONS**

### **7.1. Main achievements and effectiveness of implementation**

#### **7.1.1. Main Achievements**

The main achievements of the SESAR1 Programme are:

- The successful maintenance of the European ATM Master Plan, culminating in the 2015 edition (SJU, 2015); and
- The 63<sup>2</sup> SESAR solutions defined in the SESAR Solutions Catalogue (SJU, 2016).

Each is discussed in turn before discussion of research quality, openness and transparency, and effectiveness of implementation.

#### **7.1.2. Maintaining the European ATM Master Plan**

The first edition of the European ATM Master Plan, developed by the definition phase was published in 2008 (SESAR Consortium, 2008). Two editions of the Master Plan were produced during SESAR1: edition 2 in 2012 (SESAR, 2012) and edition 3 in 2015 (SJU, 2015). Stakeholder interviews supported the concept that each is a considerable improvement on the previous version; however, some stakeholders felt that the Master Plan Update process was too much an internal exercise of the SJU rather than a fully open and transparent process.

The Master Plan portal<sup>13</sup> contains “integrated view of the European ATM System outlining the essential operational and technology changes foreseen to deliver the SESAR contributions to the Single European Sky performance” (EUROCONTROL, SESAR, 2017).

The portal is divided in three levels:

- Level 1, Executive View;
- Level 2, Planning and Architecture View; and
- Level 3, Implementation View.

The executive view has been reworded around the concept of SESAR solutions. Apart from the explanation of solutions, it also describes the performance, business and deployment considerations and presents the main risks to the SESAR deployment.

The Level 2 of the Master Plan is a database of entity relationship based on Definition Phase (2008) nomenclature and concepts (for example OI steps rather than SESAR solutions).

The Level 3 contains the information on regional and national deployment plans. The level 2 is conceived as a bridge between the Levels 1 and 3. However, it seems inefficient as a bridge between Level 1 and Level 3. For example, Level 2 does not include the concept of “SESAR solution”.

#### **7.1.3. Developing SESAR Solutions**

Concentrating on the SESAR1 Work Programme in 2014 to 2016, the main achievements are:

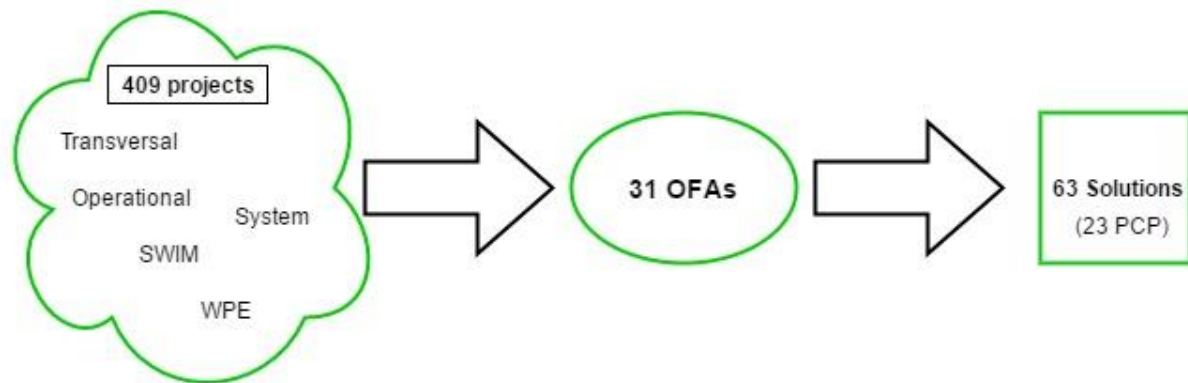
- Rationalisation of the programme in terms of Solutions,
- Closure of all SESAR1 projects,
- Dissemination of achieved results.

The SESAR1 (main) programme was characterised as complex and very fragmented, as it was composed of about 360 projects, divided into operational, technical and transversal

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<sup>13</sup> <https://www.atmmasterplan.eu/>

projects. In the last years of SESAR1, the SJU embarked on rationalisation of the programme through the application of the OFAs initially, and finally the current “Solution” approach (see Figure 6 below). “Solutions are operational and technological improvements developed by SESAR members and partners which aim to contribute to the modernisation of the European and global ATM system.” (IAS , 2016). The Solution focuses on a bundle of operational improvements and enablers that are a part of a logical whole (from the deployment and finally operational point of view). As such, it linked two, and often more SESAR1 projects. Furthermore, the Solution approach made it easier to focus on deployable outcomes from the projects. The SJU divided the Solutions into Releases, whereby a Solution that passes the V3 maturity gate (TRLs 6 and 7), is released.



**Figure 6. Rationalisation of SESAR work programme.**

The closure of SESAR1 resulted in two sets of Solutions: V3 mature and V1/V2 mature ones. The first edition of SESAR Solutions catalogue (SJU, 2016a) contains 63 mature Solutions, which are ready for industrialisation and deployment, details of which are given in Annex C). Furthermore, there are also 54 solutions developed in SESAR1, to be delivered in SESAR2020. Out of 63 delivered Solutions, 23 are related to the Pilot Common Project (Commission Implementing Regulation (EU) No 716/2014). These solutions have a mandate for deployment by SESAR Deployment Manager, as described in Section 3.1.5.

The developed Solutions would offer the following gains if widely deployed (SJU, 2016):

- Decrease of 2,4% in fuel consumptions and emissions per flight;
- 5,3% decrease of air navigation service unit costs;
- 11% increase in airport capacity;
- 39% decrease of the flight time variation;
- 33% increase in airspace capacity; all of which are steps toward achieving High Level SES goals.

#### **7.1.4. Research Quality**

All of the SESAR1 projects were closed by the 31<sup>st</sup> December 2016, among those, more than 322 industrial research projects, 45 Exploratory Research projects and 42 demonstrations.

The achievements of the SESAR1 programme consist of tangible (e.g. Solutions) and intangible components. All the interviewed and surveyed stakeholders cite the partnership approach and having European ATM Master Plan as an overarching plan as very valuable outcomes of this exercise. Cooperation with different stakeholder groups became more proactive over the years. For example, the coordination with the European Defence Agency (EDA), EUROCAE, EASA, to mention some. Also, the close cooperation with the General Aviation and Business Aviation communities (through the demonstration projects), resulted in the delivery of solutions of importance to those stakeholders (e.g. solution #113, (SJU, 2017)).

Another important intangible achievement lies in the advancement of some of the transformative concepts like virtual air traffic control centre, and the notion of componentisation of the system and service oriented architecture, thus departing from the previous monolithic system development (which was often slowing or barring the progress<sup>14</sup>). SWIM solutions are one of the major developments of the SESAR1 programme that support this departure from the monolithic vision.

What is more, the SESAR1 transversal projects developed methodologies and manuals for processes such as safety case, cost-benefit analyses, human factors, security and business case, all of which are necessary to proceed to higher TRL levels and industrialisation. These methodologies and processes are taken aboard in SESAR2020, as requirements for the Solution release.

The fact that 23 solutions are a part of the PCP and that the SESAR Deployment Manager (SDM) has a mandate to deploy them across Europe demonstrate the validity of the research performed in the SESAR1. Furthermore, some of the solutions are being implemented locally, outside of the SDM mandate. Those are mainly airport solutions that offer resilience to disruptions in the severe weather, while maintaining the capacity and safety, presenting the quick wins for the airports. For example, solution #4 Extended arrival management (AMAN) horizon that is already in use at London Heathrow airport. Remote tower (solution #12) is another example. ATC can account for about 30-40% of operating costs at small airports in sparsely populated areas, which is at odds with the need for cost-efficiency. With the Remote tower, the ATC service can be provided at much lower costs. Örnsköldsvik and Ängelholm airports<sup>15</sup> in Sweden are using the remote tower.

At the beginning of the SESAR programme, predictability was considered as a major component needed to achieve the SES High Level Goals. The research performed under the SESAR1 demonstrated that indeed predictability is important, and that it can be, and is improved. However, the full predictability required by the definition phase concept is not possible. Thus, the SESAR1 and the subsequent SESAR2020 programme switched the focus to solutions that are consistent with a certain level uncertainty – including the use of dynamic sequencing tools (such as extended AMAN).

As in any research programme, there were some disappointments. Three areas are worth of exploration: datalink, flight object and architecture.

First datalink: The positive side of SJU involvement actually stems from a serious deployment issue. In recent years, it has become apparent that the approach to deploying datalink via VDL Mode 2 as required by an EC Regulation was leading to significant issues. Following a report by EASA, the Commission tasked SESAR to investigate potential solutions – leading to the successful ELSA project. The proposed solutions have since been taken on by the SESAR Deployment Manager. This is a true success story of how a competent policy led Joint Undertaking can enable a swift intervention to resolve issues.

On the negative side, however is the lack of progress with the successor to VDL Mode 2. The SJU inherited two potential solutions, referred to LDACS1 and LDACS2. The original work programme foresaw an initial evaluation phase to select the most promising and further work to build a prototype. The down selection never occurred and this issue passes unresolved to SESAR2020.

Interestingly, the SJU has made more progress with the next generation of satellite system. Through a collaborative effort with the European Space Agency IRIS project the SJU have been able to demonstrate advanced air-ground satellite datalink based on an evolution of the existing INMARSAT system.

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<sup>14</sup> For example, a failure of FAA to develop and deploy Advanced Automation System. See Testimony GAO/T-RCED/AIMD-98-85, United States General Accounting Office, March 1998

<sup>15</sup><http://saabgroup.com/Media/stories/stories-listing/2017-02/remote-tower-revolutionises-air-traffic-management/>

Why does IRIS succeed where LDACS fails? IRIS is evolution of an existing product and has a simpler transition path; LDACS is new, it needs a strong commercial commitment to a particular solution. The SJU was unable to convince an industrial partner to invest at a time of uncertainty in the future of datalink.

The second area of concern has a similar story. Flight Object, or Flight Data Interoperability (IOP) function was also inherited by the SJU from R&D and standardisation work performed prior to SESAR. Flight Object is fundamentally different way of considering Flight Data in that it allows a persistent view of a flight to be synchronised in all connected Flight Data Processors. Different ATC units can then evaluate and execute changes to the flight consistent with the overall network constraints. This would enable full trajectory based operations. Progress in this area has been insufficient and may be overtaken by “FDP as a service” over SWIM. The issue with Flight Object appears to be a lack of agreement on how to transition to the new architecture leading to a focus on more discrete and shorter-term solutions – such as extended Arrival Manager.

Enterprise Architecture is the next area of concern. Despite the efforts of the WP B, SESAR does not have an Enterprise Architecture that is driving the programme. This is not to say that WP B has not produced an architecture – it has; but a simpler architecture focussed on the SESAR programme needs would be more beneficial in helping the SJU (and stakeholders during Master Plan update campaigns) understand the interdependencies between SESAR solutions – and in particular given the discussion above, the future role of datalink and the FDP interoperability.

The results coming from Exploratory Research in WP E were generally considered as very good and of high quality. However, there was no uptake of these results by the main SESAR programme, which was cited both in the interviews and surveys. The reasons for no uptake range from difficulty of transferring the research from TRL 0 or 1 into higher TRL levels, to the low interest in the long-term research from the SJU Members. SESAR2020 programme has been structured in a way to allow for this pull-through, and the interviews with the Members suggest that they are becoming more interested in the fundamental research. It is to be seen how it will unfold. Furthermore, two research networks were established through the funding from WP E, with the aim to lead the long term research needs of SESAR in the area of automation (Hala!) and complexity science (ComplexWorld). Some 20 PhDs were funded through these networks. Both networks were closed out in 2016. SESAR2020 launched a call for the Knowledge Transfer Network at the end of 2016, with the goal to have one network and expand its remit. In the period 2014-2016, as a part of rationalisation of the SESAR programme and in the preparation for the SESAR2020 the Multiannual Work Programme (MAWP) of SESAR 2020 (SJU, 2015a) has been prepared. In order to overcome the fragmentation of SESAR1, and focusing on deployment, the SESAR2020 programme took aboard the Solutions and joint operational and systems approach. Thus, the MAWP is structured around 20 projects (instead of previous 360 or so) which are focused on developing close-to-market/deployment solutions, which are to be transferred to Deployment Phase (either the SESAR Deployment Manager (SDM) or other stakeholders with a local benefit).

#### **7.1.5. Openness and transparency**

As can be seen in Section 6, the projects managed by the SJU attract the best players in the ATM research. Different ways of involvement – Members, Associates to Members, Associates to the SJU, sub-contractors, and beneficiaries of open calls – were available. As the work programme was more focused on development, rather than on pure research, SESAR1 saw just a small involvement of academia and research oriented SME.

In the initial years of SJU, only SJU Members and their contractors were able to obtain the details on the research performed in the main programme, through the access to the SJU extranet. The SJU website offered factsheets, and press releases. Thus, the non-Member entities could not see what and how the research was being done. It is very positive to see during this evaluation that the SJU results are now shared through the

SJU website. The SESAR Solutions catalogue (SJU, 2016a) is available for download on the SESAR JU website<sup>16</sup>, and the data packs<sup>17</sup> (detailed descriptions) are available for almost all solutions. The data packs contain technical, operational descriptions, standardisation and regulation requirements, to mention some of the information available in the pack. The availability of this data is a significant improvement in the dissemination of the research and development results outside of the strict SJU membership, when compared to the initial setup of SESAR JU.

Regarding the transparency, SJU Members and different stakeholder groups participated in the definition of the SESAR2020 multi-annual work programme (SJU, 2015a), who consider the process transparent. On the other hand, the academia stakeholders feel that they have been left out (see survey responses in Annex F), even though there is mention of the contribution by the EUROCONTROL Agency Research Team (ART)<sup>18</sup> and the Association for Scientific Development of ATM in Europe (ASDA)<sup>19</sup>.

#### **7.1.6. Effectiveness of implementation**

The R&D performed in SESAR1 matured a set of solutions that are either in the pre-industrial phase or are ready for industrialisation. In the course of the programme, SJU and its members were able to identify areas of the programme that proved either unsuccessful or not suitable for further development, and then to shift the effort to the areas that ensure achievement of EU policy goals. This is discussed further in Section 7.5.

The Annual and Multiannual work programmes are product of joint effort, taking input from the European ATM Master Plan. The research and development agenda of the SJU is set out in the European ATM Master Plan following a comprehensive planning exercise carried out in cooperation with the European Commission, Member States, various aviation stakeholders and SJU Members. Most of the stakeholders (80%, see Annex F) support this way of defining the European R&D agenda for ATM. As the Master Plan is a living document, there are suggestions to include new aspects like drones, cybersecurity, to improve the linkage to deployment and standardisation process and to ensure wider research in the future programme.

The European ATM Master Plan sets and monitors the performance of the SESAR programme. Table 14 lists the Key Performance Indicators and the progress towards set targets (source (SJU, 2016)), provided that deployment would be achieved in an optimal and timely manner.

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<sup>16</sup> [https://www.sesarju.eu/sites/default/files/solutions/SESAR\\_Solutions\\_Catalogue.pdf](https://www.sesarju.eu/sites/default/files/solutions/SESAR_Solutions_Catalogue.pdf)

<sup>17</sup> <https://www.sesarju.eu/activities-solutions>

<sup>18</sup> <http://www.eurocontrol.int/articles/agency-research-team-art>

<sup>19</sup> <http://www.asda.aero/>

**Table 14. KPIs related to ATM Master Plan performance – 2016 and comparison with 2015.**

REF	Key Performance Area	Key Performance Indicator	2016 Performance vs 2005 Baseline	2016 Validation Targets
43	Cost efficiency: ANS productivity	Gate-to-gate direct ANS cost per flight <sup>20</sup>	-5,30%	-4,19%
44	Operational efficiency	Fuel Burn per flight	-2,40%	-2,80%
		Flight time per flight <sup>21</sup>		No target
45	Capacity	Departure delay <sup>22</sup>		No target
		Additional flights at congested airports	+11%	10,40%
		Network throughput additional flights <sup>23</sup>	+38%	+34%
46	Environment	CO2 emissions	-2,40%	-2,80%
47	Safety	Accidents with ATM contribution		-40%

The calls attract all major players in the European ATM R&D, especially on the research side. The Stakeholder survey results indicate that the process of defining the work programme for the Industrial Research is inclusive of the Membership but not the wider community. There seem to be less dialogue concerning the nature of open calls (e.g. for the Exploratory Research) although the involvement of ART and ASDA as sources of ideas are noted. Most responses would support wider involvement still.

The major impact of SJU lies in its partnership: "Without the permanent partnership secured by the public-private partnership (PPP) structure, a number of valuable solutions would probably stay on the shelf or transit only slowly and in a local and uncoordinated way to implementation." (SJU, 2016).

From the SESAR Solutions Catalogue, and the existence of the SESAR Deployment Manager, it is clear that the SESAR results are indeed close-to-market, and meet the industry needs. However, as it is clear now that SESAR is becoming a long-term programme, and as its mission is concentration and coordination of all ATM research, the links to academia and research institutions needs to be strengthened in order to properly feed the innovation pipeline.

## **7.2. SESAR Joint Undertaking's performance in 2007 - 2016**

### **7.2.1. SESAR JU mission and governance**

#### **7.2.1.1. Establishing the SJU**

The SJU was established by Council Regulation 219/2007 in February 2007. This regulation was amended by Council Regulation 1361/2008 to give the SJU status as an EU-body. A full history of establishment phase is presented in the original Mid-Term Evaluation of the SJU. For this evaluation, it is considered that the modality of work of the SJU under SESAR1 was defined by:

- SJU Regulation: (Council Regulation (EC) No 219/2007) as amended by (Council Regulation (EC) No 1361/2008),
- SJU Statutes: Annex to Council Regulation 219/2007 as amended by Council Regulation 1361/2008,

<sup>20</sup> Derived from ATCO productivity improvement, considering 30% impact of ATCO costs on the ANSPs cost base and an elasticity factor of 0.75 between productivity and costs

<sup>21</sup> Derived from fuel burn reduction by deducting the contribution of OFA02.01.01 (0,78%), purely due to vertical profile optimisation.

<sup>22</sup> Derived from additional network throughput, considering an elasticity factor of 5 between delays and traffic and assuming ATFM delays account for 25% of primary delays.

<sup>23</sup> Increase in aircraft per volume in current "at-limit" airspace en-route

- SJU Financial Rules as adopted by the Administration Board (SJU-AB-033-15-DOC-01, 2015),
- The specific agreements with the two funding members,
- The membership agreements,
- The multi-lateral framework agreement (MFA) between all Members.

As an EU-body that is fully subject to the requirements of Article 208 and 209 of the EU Financial Rules<sup>24</sup> (Regulation (EU, EURATOM) No 966/2012) the SJU is required to draw up a multi-annual work programme, and annual work programme and an annual budget as well as a consolidated annual activity report.

The annual accounts are subject to audit by the Court of Auditors. Discharge of the implementation of the budget is by the European Parliament.

The SJU has established an internal audit capability (IAC) in line with Article 7a of the SJU Statutes (ADB(D)11-2010, 2010). Recent IAC audits include consideration of Human Resources, Contract Management and Internal Control Standards.

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<sup>24</sup> REGULATION (EU, EURATOM) No 966/2012 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002



In addition, the SJU is regularly audited by the Internal Audit Service of the Commission. Recent IAS audits include:

- Operational Governance and Master Plan update (2015)
- Risk Management (2014)
- Grant Management and closing of Projects (2013)

The SJU monitors all audit findings and is proactive in closing them. The high number of audits and low number of open findings provides significant evidence that the SJU has been established in accordance with its legal obligations.

The previous evaluations concluded that the SJU was established in accordance with the SJU Basic Regulations and operated in accordance with the Statutes. No additional evidence has been presented to change this view.

The FP7 (TEN-T) framework established by the SJU in accordance with their legal basis was well adapted to the management of the SJU work programme:

- The framework partnership agreement provided a good basis for executing the work programme.
- Members were able to report their financial contribution on an annual basis.
- The co-financing at a fixed rate of 50% of actual costs within the main programme as consistent with the partnership approach and leads to a consistent level of contribution for all partners.

#### **7.2.1.2. Stakeholder Involvement**

Under SESAR1, there were numerous routes to the inclusion of stakeholders:

- Membership: SJU Membership consisted of 15 Members representing 31 organisations.
- Associate to a Member: A further 13 organisations acted as "Associates to a Member" whereby they contributed to the Members formal contribution to SJU
- Associate Membership: A further 60 organisations were selected as Associate Members. The calls were specifically designed to widen involvement of SMEs, research organisation and academia.
- WP-E Open Calls: The SJU organised 4 open calls for Exploratory Research and Demonstration Activities totalling €71.1 million. A significant number of research organisations and SMEs were funded in this way.
- Stakeholder Support Contracts: The SJU organised open calls to enable stakeholder representation in the SJU work programme – typically in a review role. Contracts were awarded covering: Commercial Airspace Users, General Aviation, Professional Staff and Regulators.

In addition, sub-contracting to a Member was also permitted – indeed the MFA included "In case of subcontracting, the optimal participation of small and medium Enterprises (SMES) and research organisations shall be facilitated, and as far as possible fostered". A significant number of companies, many of whom were SMEs participated in the SJU work programme as sub-contractors but no formal estimate is available. The participation of the industry supply chain was mentioned in the survey responses.

Through these various routes, all air transport stakeholder groups are included in the work of the SJU. Compared to the situation before SESAR, there is a wider involvement of stakeholders: in particular airports and airspace users are more involved in ATM R&D than previously. There is also a more integrated approach to R&D in the sector with ANSPs, airports and manufacturers working on common projects. The atmosphere of collaboration has spread from SESAR to a new breed of industrial partnerships such as COOPANS and ITec that are beginning the transform ATM in Europe.

However, there is some evidence that the traditional research houses and academia were less involved due to the cost of Membership and relatively low funding levels. Further, there is little involvement from outside the traditional aviation sector. Given the focus on



high-TRL development rather than low-level research this is not a surprising result, but it does mean that the policy of concentration of all ATM R&D was detrimental to the involvement of Universities in ATM R&D and hence risks the future supply of both new ideas and appropriate trained staff. This was only partially rectified by WP E and Associate Membership and further efforts should be made in this direction.

#### **7.2.1.3. Governance of the SJU**

Under SESAR1, in accordance with the statutes, the decision-making apparatus consisted of the Administrative Board and the Executive Director. . The Executive Director created three supporting bodies:

- The Programme Committee
- The Scientific Committee
- The SESAR Performance Partnership.
- The Administrative Board established the Permanent Audit Panel

**The Executive Director.** The role of the Executive Director is defined in Article 7 of the SJU Statutes. All evidence consulted supports a conclusion that the Executive Director role is correctly implemented in accordance with the SJU Statutes.

**Administrative Board.** The role, responsibility and composition of the Administrative Board are defined by Articles 3, 4 and 5 of the SJU Statutes. The key issues are:

- The admin board is chaired by the representative of the EU.
- The admin board consists of representatives of the SJU Members and of the Stakeholders (Airspace Users, ANSPs, Equipment Manufacturers, Airports, Staff and Scientific Community).
- Voting rights are determined according to contribution of the Members with the exception of the representative of airspace users who received 10% of the votes.
- Voting is by simple majority except for adoption of the Master Plan for which the stakeholder representatives have a right of veto.
- The minutes and decisions of the Admin Board are published on the SJU website.

Our interviews of Admin Board members support the good functioning of the Admin Board in terms of transparency and process. It was however noted that the rationale for a decision is largely determined prior to the Admin Board with little room for debate during the admin board. This is particularly relevant for decisions where the Programme Committee has a strong role.

**Programme Committee.** The Programme Committee (PC) exists to resolve issues on the execution of the programme. The PC consists of senior representatives of the Members and is chaired by the Executive Director. Interview and survey responses suggest that the PC was successful in providing steerage throughout SESAR1.

**Scientific Committee.** The Scientific Committee (SC) was established to provide advice on the contents of the programme and in particular WP-E. Members were selected from the academic community via an open call. At the closing of the SESAR, the Scientific Committee submitted the lessons learnt (SESAR Scientific Committee, 2016) to SJU. The overall conclusion is that the SC enjoyed their involvement in the WP E and SESAR Innovation Days, but that they felt underutilised. There was a feeling that SESAR programme could have benefited more from the scientific input into the core SESAR projects as well.

**SESAR Performance Partnership.** The SESAR Performance Partnership (SPP) was designed to provide stakeholder input on the overall direction of SESAR in particular in relation to updates to the Master Plan. It was initially chaired by Olaf Dlugi (who had previously chaired the Executive Committee of the SESAR Definition Phase) and consisted of 13 senior representatives of ATM Stakeholders. However, the SPP had no

formal role (except as one source of advice to the Executive Director), so although the SPP supported the Master Plan Update Campaign in 2014, a Campaign Steering Group was also established; further the SPP areas to have played no part in the elaboration of the Pilot Common Project. The SPP has been replaced in SESAR2020 by a new arrangement specifically designed to support maintenance of the ATM Master Plan.

#### **7.2.1.4. The SJU's R&D Process**

The SJU has supported increased coordination of ATM R&D. This has been achieved both in terms of concentration of effort under a single umbrella but also in the application of common methodologies developed (or refined) within the transversal works packages. In particular execution of projects has drawn on the European Operational Concept Validation Methodology (E-OCVM, (EUROCONTROL, 2010)) and developed specific methodologies for safety case development, cost benefit analysis etc. This has led to a more harmonised approach to ATM R&D by the SESAR members.

In the interviews SJU Members noted that participation in the SJU work programme had enabled greater trust to be built between stakeholders (both within a particular sector – for example airports working more closely together and between sectors – ANSP building relationships with suppliers). This new trust has enabled further collaborations for example in forming the partnerships that now form the SESAR Deployment Manager.

Under SESAR1, contractual arrangements between Members were defined by the Multilateral Framework Agreement (MFA). The MFA defines the rules, rights, obligations and the technical and financial details relating to the Members' participation in the Programme. The MFA was signed by the SJU and all the Members participating in the implementation of the Programme, including EUROCONTROL. The MFA was successful in ensuring the long-term continuity of the partnership.

#### **7.2.2. Operational effectiveness**

As described in more detail in section 7.2.1.1, SJU is a 'Union body' under Articles 208 and 209 of the EU Financial Regulation. As such, it is subject to audits as any other Union body. In period 2014-2016, eleven audits (excluding the audits on annual accounts) have been performed, and no critical recommendations were issued (SJU, 2016). SJU reports on the audits and the actions undertaken to address recommendations coming from audits.

Furthermore, the audits so far have found that the SJU operates according to its legal framework, and no evidence was found to suggest otherwise in this evaluation.

The beneficiary survey (see Annex G) responses indicate that the beneficiaries are satisfied by the provision of services from the SJU side. Furthermore, almost all respondents (62 out of 68) agree that this type of a public-private partnership in the area of the ATM research brings better results to all ATM stakeholders in Europe, through better collaboration of all the stakeholders, cross-border initiatives and a strong link between the R&D and the wider SES policy through the ATM Master Plan.

#### **7.2.3. Operational efficiency**

Previous two evaluations have found the SESAR1 to be operationally efficient, and there was no evidence to suggest otherwise in this period. In the period 2013-2016 there were no calls for projects for SESAR1, thus the management performance indicators are not assessed.

Furthermore, the SESAR1 efforts in the said period were focused on closing the SESAR1 projects. In 2014, 74 projects were closed, and 65 in 2015. There were 270 projects still active in 2016, all of which were closed by the 31<sup>st</sup> December 2016. The SJU reviewed 1222 deliverables in the process.

Release 5 of SESAR Solutions was a part of these efforts, and within it, "36 SESAR Solutions were assessed are proposed to transition to industrialisation and deployment at ECAC level, with no further validation required ('V3' or 'TRL6 maturity level'), complementing the 25 SESAR Solutions already delivered in previous years in the context of SESAR1." (SJU, 2016)

**Table 15. Budget and management efficiency in 2015 and 2016.**

Year	Budget S2020 (€)	Budget SESAR1 (€)	Staff	Budget per head (€)	Administrative expenses (€)	Percent of total budget
2015	51.470.000	255.000.000	41	7.474.878	7.683.406	2,51%
2016	56.769.225	100.097.171	44	3.565.145	7.730.226	4,93%

It is important to note that in the period 2013-2016, SJU managed the closure of SESAR1 and the ramp-up of SESAR2020, thus the budget it managed includes both SESAR and SESAR2020 portions. Overall, in the SESAR1 the running costs of SJU were foreseen to be about 5% of the total budget. At the closure of SESAR1, the actual costs were closer to 3,5%.

The survey responses and stakeholder interviews demonstrate the high regard that SJU staff are held in by the Members. The technical ability of the SJU to support understanding of the programme and the interdependencies between projects was particularly noted as an enabler of the “partnership” that is ensuring the R&D meets the wider policy goals rather than being conducted as a series of “siloed” projects.

### 7.3. EU Added Value

The primary definition of EU Added Value is the level of leverage achieved. That is the level of private funding attracted by the EU funding. Leverage is calculated as Total leveraged funds divided by the Total EU Contribution.

For SESAR1 the anticipated leverage is 2 (€1.4 Bn / €700M). The leverage for the final outturn is estimated to be 1.8 (€1.25Bn / 700M). The final figure will not be known until the accounts are certified at the end 2017.

However, these figures could be considered artificially high due to the significant contribution of EUROCONTROL. Although not EU funding, EUROCONTROL funding is still a form of public funding as opposed to private funding.

**Table 16: Leverage Calculation for SESAR1**

Source of funding	Total	
	Budget	Outturn
EU Funding	€700 M	€700 M
EUROCONTROL	€700 M	€670 M
Industry Partners	€700 M	€584 M
Total Non EU	€1400 M	€1254 M
Leverage	2	1.79

In addition to considering leverage, it is also worth considering the potential value of deploying the SESAR solutions developed during SESAR1. The following table provides the SJUs estimates of the annual benefits if the SESAR1 solutions were widely deployed (SJU, 2016).

**Table 17. Benefits estimate from SESAR1 solutions wide deployment.**

Operational Focus Area	Total potential yearly benefits (€)
LVPs using GBAS	10.389.542
Pilot enhanced vision	Safety
Airport safety nets	Safety
Enhanced Runway Throughput	95.336.921
Optimised 2D/3D Routes	416.409.915

Free Routing	184.696.853
Business and Mission Trajectory	7.469.612
ASAS Spacing	48.086.797
ATSA-ITP	Not Assessed
ASEP	Not Assessed
Ground Based Separation Provision in En Route	210.031.057
Ground Based Separation Provision in the TMA	170.308.720
Enhanced Ground Based Safety Nets	Safety
Enhanced ACAS Operations	Safety
Integrated Arrival/Departure Management at Airports	30.155.505
Enhanced Arrival & Departure Management in TMA and En Route	51.472.347
Integrated Surface Management	149.139.082
Airport Operations Management	153.098.453
Airspace Management and AFUA	49.728.760
Dynamic Airspace Configurations	57.617.565
Enhanced ATFCM processes	129.146.192
UDPP	Flexibility of AU Ops
Network Operations Planning	Predictability
CWP Airport	Technology enabler
CWP En Route and TMA	Technology enabler
Remote Tower	21.879.719
Communication	Technology enabler
Navigation	Technology enabler
Surveillance	Technology enabler
SWIM	Technology enabler
AIM/MET	Technology enabler
Trajectory Management Framework and System Interoperability with air and ground data sharing	Technology enabler
<b>Total</b>	<b>€ 1.784.967.041</b>

Apart from the monetary values, the SJU brought a significant added value, which is not easy to monetise. Setting up an unprecedented PPP with ATM industry partners to concentrate and coordinate efforts and resources at European level to modernise ATM, which has been cited in the responses to the stakeholder survey (see Annex F). The collaborative momentum brought better coherence with EU policies, coordination and optimisation of not only R&D, but also daily operations at EU level.

## 7.4. Coherence

This section considers the coherence of SESAR1 at four different levels:

Level	Definition
Internal	The extent to which the partners within the SJU support a combined vision
FP7	The extent to which the activities of the SJU are coherent with other actions within FP7
External – Europe	The extent to which the activities of the SJU are coherent with wider EU policies and Programmes.
External - Global	The extent to which SESAR is consistent with and contribute to global interoperability through ICAO and other international programmes.

#### **7.4.1. Internal Coherence**

Coherence within the SESAR programme is maintained through the European ATM Master Plan and the multi-annual work programme. European ATM Master Plan was originally published in 2008 (SESAR Consortium) by the Definition Phase, and was endorsed by the Council on 30<sup>th</sup> March 2009 (Council Decision 2009/320/EC).

Two significant updates have been developed by the SJU – in 2012 and 2015. A further version is expected in 2018.

The adoption of the European ATM Master Plan and its updates by the SJU Admin Board signifies support from:

- EU Member States whose approval the European Commission attains by vote of the Single Sky Committee prior to voting in the Admin Board.
- EUROCONTROL Members States whose approval EUROCONTROL attains prior the voting in the Admin Board.
- The Industry Members of the SJU.
- The wider stakeholder community represented in the Admin Board. The stakeholder representatives have a veto on approval of the Master Plan<sup>25</sup>. During our interviews, it was made clear that this role is taken seriously. The Airspace User community in particular have provided detailed positions prior to the approval of each subsequent edition<sup>26</sup>.

The European ATM Master Plan provides a long term strategic programme for ATM research in line with the requirements of the Single European Sky. The Master Plan does require periodic update to reflect both progress in R&D and evolution of the ATM sector. The latest version of the Master Plan for example includes insertion of the unmanned aircraft and Cyber Security as new issues to be tackled by the SJU.

#### **7.4.2. Coherence with FP7**

The Advisory Council for Aviation Research and Innovation in Europe (ACARE)<sup>27</sup> develops and maintains Strategic Research and Innovation Agenda (SRIA) for aeronautics research that is consistent with achieving the objectives set out in Flightpath 2050 (European Commission, 2011a). FlightPath 2050 was developed by the High Level Group on Aviation Research to provide the Commission with advice on the long term future of aviation. The then Executive Director of the SJU was a member of the High Level Group.

The SJU staff have worked diligently in the ACARE working arrangements to ensure that the European ATM Master Plan is reflected in the SRIA. The Executive Director of the SJU is a member of the ACARE General Assembly.

Both Clean Sky and SESAR work programmes are related to the ACARE SRIA. The strategic planning of the SJU is however performed based on European ATM Master Plan, which is maintained through extensive consultation with stakeholders and subject to approval of Member States through the Commission's position adopted at the SJU Administration Board.

There is a clear need for coordination with Clean Sky to ensure complimentary of activities. This is achieved through regular meetings and distributions of call texts prior publication. This process was formalised by a Memorandum of Cooperation (MoC) between the CS2 JU and the SESAR JU in October 2015 *to support* (SJU, 2016c) "*sharing*

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<sup>25</sup> Article 4 (6) of the Statutes of the Joint Undertaking.

<sup>26</sup> For example Minutes of Admin Board 35 in December 2015

<sup>27</sup> <http://www.acare4europe.org/>

*of best practices, to identify gaps and secure synergies in areas where, a joint approach would be needed in respective development, validation and demonstration activities. The cooperation will also enhance the definition of the performance targets, in particular for environmental targets."*

Responses to the stakeholder survey supported the complementary nature of the research conducted by SJU and Clean Sky. However, there is evidence that the collaboration between SJU and Clean Sky could be strengthened. During the interviews it became clear that the SJU are not provided with adequate opportunity to view Clean Sky calls. It is also noted that, where a Clean Sky call covers an area of overlap, viewing call texts is insufficient to ensure value for money. SJU staff must be involved in the elaboration of the call text so that it is consistent with the SESAR work programme, clearly identifies the dependencies on and opportunities to use SESAR results and validation platforms and is consistent with the wider SJU role on coordination of ATM evolution in international fora. The coordination between Clean Sky and the SJU needs to be strengthened.

In addition to Clean Sky, complementary activities have also been funded by the European Space Agency (ESA) and the European GNSS Authority (GSA). The ESA IRIS programme is supporting the development of a next generational satellite communications solutions consistent with the SESAR requirements. The two programmes are aligned and make use of each other's validation platforms.

The GSA support actions to use EGNOS and Galileo signals within aviation<sup>28</sup>. These actions are consistent with SESAR and PCP aims to extend LPV procedures to smaller airports.

The SJU regulation is based on the principle of concentrating all ATM research and development into the SESAR development phase. In general, this means that there is little pure ATM R&D performed in the wider FP7 programme.

The process concentration did have an impact on the wider ATM R&D community in that their only source of funding from the EU is the WP-E budget in SESAR. Responses to the surveys from the R&D community felt that this exploratory research budget was too small and had led to a reduction in "low-TRL" or fundamental research within ATM.

There is also the need to strengthen SJU links to wider research on topics that affect Air Traffic Management – for example Cyber Security, or which may influence the next generation of ATM products – for example machine learning algorithms.

#### **7.4.3. External Coherence - Europe**







SESAR is recognised in the EU's 2011 White Paper (European Commission, 2011) and the Aviation Strategy<sup>29</sup> as a key enabler for the implementation of the Single European Sky. The Figure 7 illustrates the performance gains targeted by the SJU.

The SJU is a full participant in the Single European Sky Policy area. They have developed close working relationships with all the other relevant agencies and organisation including the European Aviation Safety Agency (EASA), European Defence Agency (EDA), the European Space Agency (ESA), EUROCAE – the European Organisation for Aviation Standards and the SESAR Deployment Manager.

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<sup>28</sup> <https://www.gsa.europa.eu/segment/aviation>

<sup>29</sup> [https://ec.europa.eu/transport/modes/air/aviation-strategy\\_en](https://ec.europa.eu/transport/modes/air/aviation-strategy_en)

Key performance area	SES High-Level Goals vs. 2005	Key performance indicator	SESAR ambition vs. baseline 2012	
			Absolute saving	Relative saving
 <b>Cost efficiency: ANS productivity</b>	Reduce ATM services unit cost by 50% or more	<ul style="list-style-type: none"> <li>Gate-to-gate direct ANS cost per flight</li> <li>- Determined unit cost for en-route ANS*</li> <li>- Determined unit cost for terminal ANS*</li> </ul>	EUR 290-380	30-40%
 <b>Operational efficiency</b>	-	<ul style="list-style-type: none"> <li>Fuel burn per flight (tonne/flight)</li> <li>Flight time per flight (min/flight)</li> </ul>	4-8 min 0.25-0.5 tonne	3-6 % 5-10 %
 <b>Capacity</b>	Enable 3-fold increase in ATM capacity	<ul style="list-style-type: none"> <li>Departure delay (min/dep)</li> <li>- En-route air traffic flow management delay*</li> <li>- Primary and reactionary delays all causes</li> <li>Additional flights at congested airports (million)</li> <li>Network throughput additional flights (million)</li> </ul>	1-3 min  0.2-0.4 (million) 7.6-9.5 (million) <small>Additional flights, not saving</small>	10-30 %  5-10 % <sup>1</sup> 80-100 % <sup>2</sup>
 <b>Environment</b>	Enable 10 % reduction in the effects flights have on the environment	<ul style="list-style-type: none"> <li>CO<sub>2</sub> emissions (tonne/flight)</li> <li>- Horizontal flight efficiency (actual trajectory)*</li> <li>- Vertical efficiency</li> <li>- Taxi-out phase</li> </ul>	0.79-1.6 tonne	5-10 %
 <b>Safety</b>	Improve safety by factor 10	Accidents with ATM contribution	No increase in accidents	Improvement by a factor 3-4
 <b>Security</b>	-	ATM related security incidents resulting in traffic disruptions	No increase in incidents	

\* Targeted by the Performance Scheme

<sup>1</sup> Additional flights that can be accommodated at congested airports, representing 5-10 % of flights at congested airports (~31 % of 14,4 (million) flights in 2035).

<sup>2</sup> Additional traffic accommodated in 2035 in comparison with 2012 and associated with ANSP productivity gains, enabled by SESAR. Note: Numbers are rounded.

Metrics with monetary value in business view

**Figure 7. SESAR Performance ambition (source: (SJU, 2016)).**

The importance of SESAR is further reflected in the inclusion of SESAR as a priority area within the Connecting European Facility (CEF)<sup>30</sup>. The SESAR Deployment Manager has developed a comprehensive Deployment Plan (SESAR Deployment Manager, 2016) for the Pilot Common Project, which includes 23 SESAR Solutions over 6 ATM Functionalities:

- **AF1 Extended Arrival Management and Performance Based Navigation** in high density TMAs, which is expected to improve the precision of approach trajectory as well as to facilitate traffic sequencing at earlier stage, thus allowing to reduce fuel consumption and environmental impact in descent/arrival phases;
- **AF2 Airport Integration and Throughput**, which is expected to improve runway safety and throughput, ensuring benefits in terms of fuel consumption and delay reduction as well as airport and airspace capacity;
- **AF3 Flexible Airspace Management and Free Route**, which enable a more efficient use of airspace, thus providing significant benefits linked to fuel consumption and delay reduction;
- **AF4 Network Collaborative Management**, which is expected to improve the quality and the timeliness of the network information shared by all ATM stakeholders, thus ensuring significant benefits in terms of ANS (Air Navigation Service) productivity gains and delay cost savings;
- **AF5 iSWIM (initial System Wide Information Management)**: ground-ground integration and aeronautical data management & sharing, which consists of a set of services that are delivered and consumed through an IP-based network by SWIM enabled systems, enabling significant benefits in terms of ANS productivity;
- **AF6 Initial Trajectory Information Sharing**: air-ground integration towards i4D with enhanced Flight Data Processing performances, which is expected to improve predictability of aircraft trajectory for the benefit of both airspace users, Network Manager and ANSPs implying less tactical interventions and improved de-

<sup>30</sup> CEF: <https://ec.europa.eu/inea/en/connecting-europe-facility/cef-transport/projects-by-transport-mode/sesar>



confliction situation. This would have a positive impact on ANS productivity, fuel saving and delay variability.

The SDM supported stakeholders respond to INEA calls in 2014 and 2015 leading to over €1Bn of investment in SESAR solutions in over projects and 25 countries. The Cost Benefit Analysis of the PCP estimated a potential net benefit of €1.7Bn (NPV)<sup>31</sup>.

#### **7.4.4. External Coherence – Global**

At global level, ATM is regulated by the International Civil Aviation Organisation (ICAO). In particular ICAO develops the Standards and Recommended Practices (SARPs) that define how Air Navigation Services are provided. SES builds on ICAO principles.

In order to support the modernisation of ATM globally, ICAO has developed a series of Global Air Navigation Plans (GANP). For the fourth edition published in 2014 (ICAO Doc 9750-AN/963, 2014), ICAO undertook significant work to reflect advances in Air Traffic Management – introducing the concept of Aviation System Block Upgrade (ASBU) as a way of describing the long term evolution of ATM. Europe, the EU and SESAR strongly supported this work; the resulting GANP and ASBUs reflect the SESAR work programme<sup>32</sup>.

The strong links between SESAR and ICAO have two beneficial effects:

- a) It ensures that SESAR and other regions remain synchronised.
- b) It ensures that SESAR solutions have a global market.

In addition to working with ICAO, the SESAR Joint Undertaking has developed a working relationship with the FAA on NextGen<sup>33</sup> under the auspices of the EU/USA Memorandum of Cooperation on Civil Aviation Research and Development (EC COM(2011) 44 Final).

In addition, the SJU has established cooperation with Brazil, Japan, China, Australia, Singapore, Africa the Gulf States (SJU, 2016, p. 156).

Further the SJU supports its Members through active participation in global trade shows – helping ensure the global competitiveness of the SESAR solutions.

### **7.5. Relevance**

As discussed in Section 3.2, SESAR was initiated at the request of the industry to resolve a structural issue within Air Traffic Management. SESAR, as part of the wider SES policy, aims to transform ATM from both a technological and organisational perspective.

The economic benefits of SESAR were established in 2011 in a macro-economic study as “The on-time implementation of SESAR, compared with a scenario in which ATM is not modernised, would have a positive impact on GDP estimated at €419 Bn. This represents 0,16% of combined EU27 GDP over the considered period. SESAR would contribute by an additional 0,02 percentage point to EU27 annual GDP growth, with 328.000 new jobs and 50 million tons of CO<sub>2</sub> emissions saved”.

This result continues to be relevant; modernisation of the ATM remains a key enabler air transport and GDP growth as highlighted in the European Commission’s Aviation Strategy<sup>34</sup>.

However, it is now clear that the SES High Level Goals will not be achieved by 2020 as originally envisaged. A key factor is that traffic did not evolve as predicted in 2007. At that time, it was predicted that traffic would double by 2020 – this meant that the cost

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<sup>31</sup>[https://ec.europa.eu/transport/sites/transport/files/modes/air/sesar/doc/ec-716-2014\\_article4c\\_globalcba.pdf](https://ec.europa.eu/transport/sites/transport/files/modes/air/sesar/doc/ec-716-2014_article4c_globalcba.pdf)

<sup>32</sup> See Annex A of the European ATM Master Plan, Edition 2015.

<sup>33</sup> NextGen: <https://www.faa.gov/nextgen/>

<sup>34</sup> [https://ec.europa.eu/transport/modes/air/aviation-strategy\\_en](https://ec.europa.eu/transport/modes/air/aviation-strategy_en)



efficiency goal could be largely achieved by enabling the additional traffic without increasing overall costs. This would have led primarily to a focus on increasing air traffic controller productivity – that is doubling the air traffic controller’s productivity.

Even with traffic growth returning, traffic is still not predicted to reach double the level of 2006 by 2030 (Network Manager, 2013). This has led to a shift in requirements placed on SESAR: rather than a focus on building additional capacity, the focus is on cost-efficiency and environmental performance. The need is for a more flexible approach that can better optimise network resources to evolving demand. This type of approach is consistent with the long-term planning scenarios for air traffic management developed as part of the “Challenges to Growth 2013” project (Network Manager, 2013a).

The SES has also seen a shift from a prescriptive approach (SES1) to a performance approach (SES2). Achievement of the High Level Goals is therefore part of the wide SES policy including the role of the Performance Scheme, Network Manager and Functional Airspace Blocks.

The role of SESAR programme is to support the technological modernisation of ATM. The Development Phase supports this in three ways:

- By maintaining the European ATM Master Plan
- By creating a cross-industry collaborative platform that goes beyond the R&D remit.
- By generating SESAR Solutions that are deployed either voluntarily on a local basis or as part of an EU mandate under the SESAR Deployment Manager.

As the SESAR1 work programme was conducted a technological shift occurred. The original ATM master plan was based on networking ATM systems using a common internet known as SWIM. SESAR now foresees SWIM as distributing services rather than just data. This will enable some ATM services to be provided as a “common service” across multiple service providers leading to lower implementation and operational costs.

The continued success of the SJU lies in building links with the development phase to ensure that SESAR solutions are deployed in a manner that best supports achievement of the SES high level goals.

## 8. CONCLUSIONS

The SESAR Joint Undertaking was established in 2007 to manage the development phase of SESAR in accordance with the European ATM Master Plan. SESAR1 formally ceased on December 31<sup>st</sup> 2016 – but has been succeeded by SESAR2020.

The major achievements of SESAR1 are:

- Completion of over 400 projects, 350 validation exercises and 30,000 flight trials leading to...
- ...63 SESAR Solutions (new or improved operational procedures or technologies) of which...
- ...23 are already mandated for deployment by the SESAR Deployment Manager under the Pilot Common Project regulation; illustrating...
- ...A strong and leading brand for ATM modernisation both within Europe and globally.

The success of SESAR is best illustrated by the European ATM Master Plan (SJU, 2015) and SESAR Solutions Catalogue (SJU, 2016). These two documents define the intent and output of the SESAR1 programme; together with the detailed results of the SESAR1 Programme (the Solution Packs) they have enabled Europe to play a leading role in setting global standards in ICAO and in particular in the definition of the Global Air Navigation Plan (GANP) (ICAO Doc 9750-AN/963, 2014).

The quality of the SESAR output is therefore not only illustrated by initial deployments of SESAR solutions by the SESAR Deployment Manager but also by the deployment of SESAR solutions on a voluntary basis both in Europe (for example Remote Towers in Sweden and Ireland) and globally (for example Abu Dhabi are currently evaluating implementation of both Remote Tower and Time Based Separation/EU RECAT).

Throughout our evaluation SJU Members and ATM Stakeholders have highlighted the importance of **SESAR, and the SJU, as a key enabler of the wider SES policy**:

- The SJU and its Members have formed an unprecedented public-private partnership (PPP) that co-ordinated and concentrates effort and resources at European level to achieve modernisation of ATM.
- The Network investors (airlines, airports, ANSPs) are confident that this PPP is delivering the necessary solutions to achieve this ATM modernisation.
- The partnership approach of "working together" has led to partnerships beyond the SJU scope (e.g. COOPANS, ITec, Borealis) that are leading to operational improvements across Europe.
- Manufacturers support the SJU because it provides access to operational stakeholders and hence improves their R&D leading to products with increased market potential.
- Whilst the wider supply chain of the manufacturers (and large ANSPs), typically made of SMEs, is not directly represented in the SJU Membership they are active in SESAR work programme through subcontracting arrangements and the various forms of membership, like Associate Member. The SJU has therefore led to a wide and inclusive participation in ATM R&D.
- There is wide support for the main focus of the programme on developing and maturing solutions for deployment (high TRL research). The limited funding available for low TRL research (e.g. WP-E) in SESAR1 has led to an issue with improving pull-through of low TRL research and building stronger links with the scientific community.

Overall the evaluation of the SJU under SESAR1 is extremely positive; but there is a word caution. Progress is not as originally hoped for in the definition phase, for example:

- Despite significant progress, the Enterprise Architecture did not reach a sufficient level of maturity to support deployment planning and does not efficiently link the three levels of the European ATM Master Plan.
- Key technical enablers such as a terrestrial replacement for VDL Mode 2 (e.g. LDACS) have not progressed sufficiently to de-risk some of the advanced concepts that rely on secure and timely air-ground datalink.

It is important that the European ATM Master Plan updates reflect on these issues to ensure evolving needs are reflected in the future work programme.

Further, the policy of concentrating ATM R&D in the SJU limited the opportunities for academia in ATM R&D (due the limited budget available for WP-E, and lack of national funds). This would not be sustainable in the long term, as it would restrict the availability of trained staff for future developments.

In terms of the main evaluation criteria:

<b>Effectiveness</b>	<p>The SJU has been effective in organising the activities of the SESAR Development phase. This includes maintenance of the ATM Master Plan, delivering the R&amp;D programme and building European and international links to ensure global interoperability and European leadership in ATM solutions.</p> <p>For the main part the Work Programme has been successfully executed leading to 63 mature solutions. As expected with such a large programme (409 projects), some notable exceptions do exist – but the overall success rate is impressive.</p>
<b>Efficiency</b>	<p>Previous evaluations indicate that the SJU is compliant with the Regulations and efficient as an organisation. The SJU staff has successfully and efficiently managed a complex R&amp;D programme in a manner that has built a strong partnership for ATM modernisation.</p> <p>This is illustrated by the SJU's ability to simultaneously close the SESAR1 work programme and launch the SESAR2020 programme.</p>
<b>Relevance</b>	<p>The work of the SJU is assessed as having continued relevance to the ATM Stakeholders. The SJU and its Members are a strong partnership committed to achieving the SES High Level Goals. The successful maintenance of the European ATM Master Plan ensures that the SJU work programme maintains relevance as external factors evolve.</p> <p>The value of SESAR as a modernisation programme is now becoming obvious, with the successful launch of the Deployment Phase leading to European-wide deployment of SESAR solutions.</p>
<b>EU Added Value</b>	<p>The expected leverage for SESAR1 is 1.8. The 50% co-funding of the Industry is consistent with a partnership.</p> <p>Additional EU added value is achieved through the collaborative partnership of the SJU and the momentum created for the modernisation of ATM and reaching the SES High Level Goals.</p>
<b>Coherence</b>	<p>The activities of the SJU have been evaluated as being coherent at four levels:</p> <ul style="list-style-type: none"> <li>• Internal – through maintenance of the Master Plan,</li> <li>• FP7 – through coordination with ACARE and Clean Sky,</li> <li>• EU- through the strong policy link with the SES and coordination with the wider SES actors including EASA, EDA, EUROCAE and the SESAR Deployment Manager,</li> <li>• Globally – through strong links with ICAO, the FAA (NextGen) and</li> </ul>

	other national and regional programmes.
<b>Openness and Transparency</b>	<p>The work of the SJU is considered to be open and transparent.</p> <p>The Administrative Board Minutes, Decisions, along with the accounts and annual reports are all publicly available.</p> <p>SJU publications are well received – particularly the European ATM Master Plan and SESAR Solutions Catalogue which together define the objective and results of the SESAR Development Phase. Each solution is supported by a detailed set of documentation (Solution Pack) designed to support implementation which are all publicly available.</p> <p>The SJU promotes SESAR at trade shows and other public events and is active on social media with a positive presence on LinkedIn and Twitter.</p>
<b>Research Quality</b>	<p>Research Quality is assessed as excellent. The SJU Members provided world class researchers who developed high value deliverables. This is evidenced by the uptake of SESAR solutions both in Europe and worldwide.</p>

## 9. RECOMMENDATIONS

Overall, our conclusions are positive and reinforce the findings of the previous evaluations and support the extension of the SESAR Joint Undertaking. Our analysis suggests three potential areas of improvement. All three relate to how the activities of the SJU can support the longer-term role of SESAR as a modernisation programme with a strong link the Single European Sky policy area.

### **Rec 1: Strengthen the “partnership approach” including links to deployment**

With the launch of the SESAR Deployment Phase, the European ATM Master Plan has a growing importance beyond being a blue print for the necessary R&D. Rather it should be considered a strategy document for contributing to the achievement of the SES High Level Goals. In this regard, the European ATM Master Plan should further strengthen inputs from:

- The wider industry (whether a member of the SJU or not).
- The Performance Review Body on current performance and performance shortfalls.
- The Network Manager on how network functions should evolve and contribute to the high level goals.
- The SESAR Deployment Manager in terms of the support required to achieve widespread adoption of SESAR solutions.
- EASA in terms of how solutions can be regulated (from a safety perspective).

These connections already existed, but to some extent were managed in an ad-hoc manner. Master Plan update programmes can only benefit if the supporting activities become even more inclusive and secure greater transparency. It is recognised that the creation of the Master Planning Committee in SESAR2020 starts to address this issue.

### **Rec 2: Strengthen the “architecture” of the Master Plan to enable the Commission to streamline deployment planning and monitoring.**

The European ATM Mater Plan consists of three layers:

- The Executive level which sets out the strategy for SESAR,
- The Planning and architectural view which sets out how SESAR elements contribute to the overall system; and
- The Implementation view which sets out the deployment of specific elements.

Currently all three views use different language to describe the same concepts. It is therefore difficult to assess their consistency. It is recommended that Level 2 is reorganised around the principles of SESAR solutions and that Level 3 is streamlined to include deployment monitoring activities of the SESAR Deployment Manager as well as voluntary reports from stakeholders, avoiding multiple reporting. In this way, the Master Plan can become an even more coherent tool for planning the overall SESAR deployment and monitor its achievement.

### **Rec 3: Strengthen the links to academia to ensure the innovation pipeline is fed with new ideas**

As initially conceived the SESAR Development Phase was a relatively short programme designed mainly to mature ATM concepts and technologies to accelerate their deployment. The focus was on concentrating the efforts of the industry (suppliers and service providers) on the necessary development work. It was not deemed a priority to build links to universities in order to secure a pipeline of new ideas and future workforce.

It is now clear that SESAR is a long-term programme that needs to evolve to take account of influences beyond ATM and respond to new challenges facing the community –

for example drones, cybersecurity, big data, machine learning, and new approaches to regulation. To achieve this, the links to academia need to be strengthened.

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## 11. ANNEX A: ACRONYMS

Acronym	Definition
4D	Four dimensional
A6	A6 Deployment Manager Alliance
ACC	Area Control Centres
A-CDM	Airport Collaborative Decision Making
ACI	Airports Council International
AIRM	ATM Information Reference Model
AMAN/DMAN	Integrated arrival and departure management
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOC	Air Operations Centre
AOP	Airport Operation Plan
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
APOC	Airport operation centre
APV	Approach Procedures with Vertical Guidance
ASBU	Aviation System Block Upgrade
ASD	Aerospace and Defence Industries Association of Europe
A-SMGCS	Advanced-Surface Movement Guidance and Control Systems
ASPA	Airborne spacing
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATSEP	Air traffic safety electronics personnel
CANSO	Civil Air Navigation Services Organisation
CDA	Continuous descent approach
CDM	Collaborative Decision Making
CNS	Communication, Navigation, Surveillance
CONOPS	Concept of Operations
cPPP	contractual Public-Private Partnership
CS	Clean Sky
CSA	Coordination Support Action
EASA	European Aviation Safety Agency
EC	European Commission
EDA	European Defence Agency
E-OCVM	European Operational Concept Validation Methodology
ER	Exploratory Research
ESARRS	EUROCONTROL's Safety Regulatory Requirements
EU	European Union
FAA	Federal Aviation Authority
FAB	Functional Airspace Block
FCH	Fuel Cells and Hydrogen
FDP	Flight Data Processor

FOC	Flight Operations Centre
FP6	Framework Programme 6
FP7	Framework Programme 7
GA	Grant Agreement
GANP	Global Air Navigation Plan
GAP	Grant Agreement Preparation
GNSS	Global Navigation Satellite System
H2020	Horizon 2020
IA	Innovation Action
ICAO	International Civil Aviation Organisation
IMI	Innovative Medicines Initiative
IPR	Intellectual Property Rights
IR	Implementing Rule
IR&V	Industrial Research
ISRM	Information Service Model
JU	Joint Undertaking
KPI	Key Performance Indicator
LTP	Linked Third Parties
MAWP	MultiAnnual Work Programme
MET	Meteorological
MFA	Multilateral Framework Agreement
MoC	Memorandum of Cooperation
NOTAM	Notice to Airmen
NSA	National Supervisory Authority
OFA	Operational Focus Area
PC	Programme Committee
PHARE	Programme for Harmonised ATM Research in EUROCONTROL
PPP	Public Private Partnership
PRB	Performance Review Board
R&D	Research and Development
R&I	Research and Innovation
RBT	Reference Business Trajectory
RDP	Radar Data Processes
RIA	Research and Innovation Action
RNAV	Area navigation
RPAS	Remotely Piloted Aircraft Systems
S2R	Shift to Rail
SARP	Standards and Recommended Practices
SC	Scientific Committee
SDM	SESAR Deployment Manager
SES	Single European Sky
SES1	First Single European Sky legislative package
SES2	Second Single European Sky legislative package
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SME	Small and Medium-sized Enterprise

SoA	Service Oriented Approach
SPP	SESAR Performance Partnership
SRIA	Strategic Research and Innovation Agenda
SWIM	System Wide Information Management
TJU	Transport Joint Undertaking
TMA	Terminal Maneuvering Areas
TOR	Terms of Reference
TRL	Technology Readiness Level
UDPP	User Driven Prioritisation Process
V	Validation phase (in E-OCVM)
V&VI	Verification and Validation Infrastructure
VLD	Very Large Demonstration
WOC	Wing Operations Centre
WP E	Workpackage E

## **12. ANNEX B: SESAR1 WORK PACKAGE DESCRIPTIONS**

### **12.1. Overview**

The SESAR1 work programme consisted of over 300 projects grouped in to 18 work packages. All work packages except for WP E were performed by the SJU Members under restricted calls. WP E was performed by contractors under open calls.

### **12.2. WP3 Validation Infrastructure Adaptation and Integration**

WP3 tracked Industry-Based/Pre-Operational Verification and Validation Platforms to include simulation, shadow mode and/or live trials capabilities, and preparing SESAR Verification and Validation Infrastructure (V&VI) that included the set of preparation/analysis tools, Validation and Verification facilities and test equipment.

The objective of WP3 was to support the SESAR Partners and operational and technical threads to define and coordinate the timely evolution and setting up of Verification and Validation Platforms along with the required support to adaptation and integration of the relevant tools and prototypes focusing on V2 and V3 maturity phases.

### **12.3. WP4 En-Route Operations**

Work Package 4 provided the operational concept description for the En- Route Operations and performed its validation. The term "En-Route" includes both 'continental' and 'oceanic' applications. The applications of 4D and performance-based operations were the cornerstones of future en-route operations. The objectives were to demonstrate the operational feasibility of the En Route Operations concept in a complete ATM environment (including systems) in order to: improve the provision of the Separation service through the development of concept using advanced RNP capabilities, full aircraft capabilities in terms of 4D while optimizing the controller work (evaluating the concept of Multi Sector Planners for improve sector productivity); improve the ground safety nets functionalities considering the proposed operational functionalities such as the use of Downlink Aircraft Parameters, or the improved air ground collaboration; improve the airborne safety nets in order to reduce false alerts and to consider latest evolutions. Had the portfolio of 16 R&I projects.

### **12.4. WP5 TMA Operations**

Work Package 5 defined the Terminal Manoeuvring Area (TMA) ATM Target Concept (i.e. Concept of Operations, System Architecture & enabling technologies). This covers all phases of planning and execution of flights/trajectories and the identification of supporting technical systems/functions necessary for TMA Operations. TMA Operations are considered as those from 'top-of-descent' until landing and from take-off until 'top-of-climb'. Also, the applications of 4D, time-based operations are seen as a cornerstone of future TMA and En-route operations. In particular, WP5 strived to demonstrate the operational feasibility of the TMA Operations concept in a complete ATM environment (including systems) in order to improve the Traffic Synchronisation service through the development of concept using advanced RNP capabilities, full aircraft capabilities in terms of 4D while optimizing the controller work by evaluating the concept of Multi Sector Planners for improving sector productivity; improve the Vertical Profile management functionalities considering the RNAV aircraft capabilities; improve the Controller Working Position for both En Route and TMA Operations.

### **12.5. WP6 Airport Operations**

WP6 addressed developments associated with the 'airside' elements of airport operations. To ensure effective planning and management, 'landside' elements (such as passenger and baggage handling) are also being taken into consideration, but with associated developments being undertaken outside SESAR. Particular objectives are: to develop collaborative airport planning, monitoring and management including development of the Airport Operations Plan (AOP) and the Airport Operations Centre (APOC), as well as improvements to Airport CDM; improve the management of airport surface traffic (which includes aircraft and vehicle traffic) through the definition of safety nets to prevent

conflicts and collisions, as well as the better routing, guidance and tactical planning of traffic movements under all weather conditions; improve runway management through enhanced procedures, dynamic separations (including wake vortex) and the definition of associated system operational requirements (both ground and airborne). The focus is on improving runway throughput at all times, whilst preventing runway incursions and reducing queuing; improve the provision of aerodrome control services for small and medium airports through the development of the remote tower concept, and maximise the available airport capacity through the use of remote contingency towers. These objectives are being achieved through a portfolio of 17 R&I projects.

#### **12.6. WPs 7 and 13 Network Operations**

The scope of the Network Operations Work Package covers the evolution of services taking place in the business development and planning phases to prepare and support trajectory-based operations including airspace management, collaborative flight planning, demand capacity balancing and Network Operations Plan (NOP). It encompasses the services included in the execution phase to facilitate trajectory-based operations in case of capacity issues. The specific objectives covered: development of the methodologies for airspace management and organisation, including processes for an improved flexible use of airspace, the accommodation of user preferred routes and dynamic airspace configurations; development of the Business/Mission Trajectory management (including the Shared Business Trajectory, used for advanced planning and the Reference Business trajectory, which is the final and agreed trajectory); definition and development of the User Driven Prioritisation Process (UDPP), whereby operators can apply their own priorities during periods of capacity shortfall, based upon a CDM approach; further development of the Network Operations Plan (NOP), a dynamic rolling plan providing a detailed overview (past, current and forecast) of the European ATM environment to those concerned; improvement of Demand Capacity Balancing (DCB) process to ensure that the ATM network is able to meet the demands of all users, taking into account the 4D trajectories, described through Reference Business Trajectories (RBT); development of improved flight briefings for pilots and flight dispatchers, through the use of integrated digital Aeronautical (including Digital NOTAM) and MET data.

#### **12.7. WP8 Information Management**

In order to realise the concept of SWIM (System Wide Information Management) for ATM, which is needed to achieve interoperability and inter-system seamless operations, WP8 primarily defines the ATM Information Reference Model (AIRM) and the Information Service Model (ISRM) to be used by the various ATM services and necessary to develop the SWIM specifications and test platforms. In particular, the objectives were to: describe the performance and operational requirements of ATM wide information sharing; contribute to the definition of the Information View of the European ATM Architectural Framework and the ATM Information Model; develop and document the European ATM Information Reference Model (AIRM); support the standardisation of ATM Information; secure semantic and syntactic interoperability within ATM for Europe and support to an overall global commitment in the same field; be responsible for ensuring the effectiveness and integrity of the functional architecture for Information Management; integrate the ATM world in the information sense, a necessary step towards the realisation of Service Oriented Approach (SoA).

#### **12.8. WP9 Aircraft Systems**

WP9 covered the required evolutions of the aircraft platform, in particular to progressively introduce 4D Trajectory management functions in mainline, regional and business aircraft to provide 4D trajectory management capabilities. In addition, the Work Package developed the necessary technological solution in support of the SESAR operational validation and ATM solutions. In particular, the objectives are: to introduce progressively the 4D Trajectory management functions like the downlink of airborne computed predictions, or improved time constraints management capabilities for Continuous Descent Approaches, finally leading to ensuring that the aircraft is able to compute and to share reliable gate to gate 4D trajectory predictions with the ground and execute the agreed reference trajectory with possibly imposed times constraints; to enhance On-board approach functionalities and validate them to provide improved and all weather operations (initial CAT II/III GBAS L1 approach for new aircraft, or GBAS Cat

II/III in the airborne equipment); to develop future on-board surveillance systems, including dedicated wake encounter and significant weather (e.g. clear air turbulence) avoidance functions, to reduce the risk of severe upsets due to atmospheric disturbances; to address environmental impact through Advanced Continuous Descent Approach aiming at minimising fuel burning and emissions, and decreasing noise; to improve surface movement operations through the introduction of functions to initially provide guidance and then alerting on traffic; ensure interoperability between civil "Business trajectories" and military "Mission Trajectories"; to provide a globally compatible avionics transition roadmap supporting the different SESAR Steps, to be used as a reference by avionics and airframe manufacturers for development planning; to develop a gradual evolution of Airborne Separation Assistance services allowing first to an aircraft to establish and maintain time spacing from a target aircraft designated by the Air Traffic Controller (ASAS-Spacing). On-board functions will be further validated to gradually introduce ASAS Separation Crossing and Passing manoeuvres with the aim to help controllers in resolving conflicts between aircraft by temporarily delegating to the Pilots the responsibility to do the requested manoeuvre and maintaining separation during that manoeuvre.

### **12.9. WP10 En-Route and Approach ATC Systems**

The scope of this Work Package covers En-Route & TMA ATC System systems' changes, and related technical activities of phases V1-V3 of the development lifecycle reference model (i.e. up to the validation of system performance using pre-industrial prototypes). It addresses system/technical aspects such as functional and technical architecture, technical performance & safety requirements, technical interoperability requirements, associated specifications, models/simulation platforms and prototypes, technical validation and the development of inputs /proposals to technical standards groups. In particular the objectives were: ATC system impact analysis of the operational improvements and identification of the induced system requirement to implement the evolution; technical feasibility assessment of the operational changes from an architecture and technology point of view; definition, design, specification and validation of the En-route & TMA ATC Systems needed to support the SESAR ATM target concept; prototype development for system and operational validation.

### **12.10. WP11.01 Flight Operations Centre**

The scope of 11.01 covers Flight Operations Centres and Wing Operations Centres, the concept development, validation, system development and verification. The objective is to provide the system definition and contribution to operational validations for a generic Flight Operations Centre / Wing Operations Centre (FOC/WOC) that meets the user needs operating in the SESAR target ATM network. A key aim is to promote effective collaboration and interoperability between the FOC/WOC and the rest of the ATM system.

### **12.11. WP11.02 Meteorological Information Services**

The scope of the Work Package, covers promoting current and future MET capabilities with the aim of gathering robust and detailed requirements for MET data and services; the design and development of MET infrastructure (including MET prototypes and the 4DWxCube) to support validation. In particular, the Work Package addressed the requirements for meteorology within the SESAR Programme, especially the impact meteorology will have on 4D trajectory based systems of the future, and in managing predictability in an efficient way. When considering the integration of MET with the rest of SESAR, the role of 11.02 is the provision and exchange of MET information, while the integration and use of MET information is performed by the operational projects.

### **12.12. WP12 Airport Systems**

The Work Package defined, designed, specified and validated the airport systems needed to support the SESAR ATM target concept. It addressed system/technical aspects such as functional and technical architecture, technical performance & safety requirements, technical interoperability requirements, associated specifications, models/simulation platforms and prototypes, technical validation and the development of inputs/proposals to technical standards groups. WP 12 provided the ground-based system support to the

new concepts, procedures and practices described by WP06. The objectives were to: support collaborative airport planning, including decision support and sequencing tools, meteorological observation and forecasting systems; improve airport surface management, including advanced surveillance techniques, ground based safety nets, ground-based routing and guidance systems as well as sequencing tools (e.g. A-SMGCS and integrated AMAN/DMAN); define and develop new runway management tools and systems supporting the dynamic application of wake vortex separations; improve safety through the definition and development of ground-based safety nets, with a priority upon detecting runway incursions and preventing collisions; define and develop the technical systems associated with the remote towers, including the appropriate surveillance means. The work was performed through 22 R&I projects.

#### **12.13. WP14 SWIM Technical Architecture**

The SWIM technical architecture Work Package is the follow-up in the context of SESAR of the SWIM-SUIT European Commission's FP6 project. It uses as an input the SWIM-SUIT deliverables and adapts them and/or further develops them to cope with the SESAR Work Programme components. The primary objectives are to define and validate the technical infrastructure solution for SWIM addressing the requirements received from WP8 and interfacing with all other System WPs (9-15).

#### **12.14. WP15 Non Avionic CNS System**

The Work Package addressed CNS technologies development and validation, considering their compatibility with the Military and General Aviation user needs. It identified and defined the future mobile datalink systems to serve communication and surveillance services, the ground SWIM backbone system. It addressed the best combination of GNSS and non-GNSS Navigation technologies to support Performance Based Navigation and precision approach requirements. It proceeded to the optimisation of the ground Surveillance infrastructure, the evolution of the Ground surveillance station to introduce ADS-B information as well as the development of Airport weather information services.

#### **12.15. WP16 R&I Transversal Areas**

The scope covers the improvements needed to adapt the Transversal Area (TA) (safety, security, environment, human performance and CBA/business Case) management system practices (e.g. guidelines, tools for analyses, etc.) to SESAR as well as towards an integrated management system. WP16 provided support and coordination to all operational and technical Work Packages for consistent and coherent application of the already existing as well as newly developed TA-related practices.

#### **12.16. WPB Target Concept and Architecture Maintenance**

The scope of the Work Package covers the maintenance and refinement of the high-level ATM Performance Target and Architecture including the Concept of Operations (CONOPS). Defining and ensuring ATM architecture consistency for all SESAR projects. WPB also conducts performance analysis of the ATM Target Concept throughout the SESAR development phase.

#### **12.17. WPC Master Plan Maintenance**

The Work Package administrated the up-to-date maintenance of the European ATM Master Plan to monitor the progress of development and of implementation. It also maintained the standard and regulatory roadmaps. In particular, the objectives were: to maintain Master Plan information up to date and monitor the progress of development and of implementation of the Master Plan by reference to the baseline; to administrate the overall process to keep the Master Plan up-to-date, and propose amendments to the SJU Administrative Board; to administrate the process that delivers the Single European Sky Implementation Plan and provides input for development of local/regional performance based implementation plans and targets; to monitor and report on the achievement of these local/regional plans and also derive the impact on system wide performance; to implement a comprehensive standards and regulatory management process, fully integrated within the SESAR Master Plan maintenance, and interfaced with the SJU work programme from the early identification of needs for new standards and regulations, to contributing to their definition, development and validation.



#### **12.18.        *WPE Long Term and Innovative Research Programme***

Long term/innovative research addressed knowledge creation and breakthrough technologies/concept elements beyond the current SESAR vision in the main stream of SESAR work programme; it has been launched in the framework of WP E to complement advanced research in aeronautics. WP E encouraged the ATM research that explores novel, unconventional areas involving new technologies, concepts or ideas. It stimulated long-term research thinking, creativity and innovation to help develop the scientific knowledge aimed at extending the SESAR vision and to complement existing SESAR activities, thus assuring the continuity in implementations beyond the existing horizons (both in time and scope).

## 13. ANNEX C: SESAR1 SOLUTIONS

### 13.1. *SESAR Solutions*

Area	Description
High-performing airport operations	The future European ATM system relies on the full integration of airports as nodes into the network. This implies enhanced airport operations, ensuring a seamless process through collaborative decision making (CDM), in normal conditions, and through the further development of collaborative recovery procedures in adverse conditions. In this context, this feature addresses the enhancement of runway throughput, integrated surface management, airport safety nets and total airport management.
Advanced air traffic services	The future European ATM system will be characterised by advanced service provision, underpinned by the development of automation tools to support controllers in routine tasks. The feature reflects this move towards further automation with activities addressing enhanced arrivals and departures, separation management, enhanced air and ground safety nets and trajectory and performance-based free routing.
Optimised ATM network services	<p>An optimised ATM network must be robust and resilient to a whole range of disruptions, including meteorological and unplanned events relying on a dynamic and collaborative mechanism. This will allow for a common, updated, consistent and accurate plan that provides reference information to all planning and executing ATM actors.</p> <p>This feature includes activities in the areas of advanced airspace management, advanced dynamic capacity balancing (DCB) and optimised airspace user operations, as well as optimised ATM network management through a fully integrated network operations plan (NOP) and airport operations plans (AOPs) via system-wide information management (SWIM).</p>
Enabling aviation infrastructure	The enhancements described in the first three key features will be underpinned by an advanced, integrated and rationalised aviation infrastructure, providing the required technical capabilities in a resource-efficient manner. This feature will rely on enhanced integration and interfacing between aircraft and ground systems, including ATC and other stakeholder systems, such as flight operations and military mission management systems. Communications, navigation and surveillance (CNS) systems, SWIM, trajectory management, Common Support Services and the evolving role of the human will be considered in a coordinated way for application across the ATM system in a globally interoperable and harmonised manner.

## **13.2. High Performing airport operations**

### **13.2.1. Precision approaches using GBAS Category II/III**

For more than 50 years airports have relied on instrument landing systems (ILS) to provide pilots with approach and landing guidance in low-visibility conditions, such as heavy rain and low cloud. Although the system has proved to be reliable and functional, ILS is costly to maintain and has operational limitations that reduce runway capacity in certain conditions. It is no surprise then that airports are turning to other solutions, such as ground-based augmentation of satellite navigation systems (GBAS), to meet their capacity needs and reduce delays and disruptions for airspace users and passengers.

#### **Benefits**

- Improved resilience by limiting the capacity reduction in degraded situations and by avoiding critical and sensitive areas)
- Reduced installation and maintenance costs compared to ILS
- Maintained level of safety
- Greater frequency efficiency
- Improved environmental impact due to shorter routes and noise abatement

### **13.2.2. Time-based separation**

Today, aircraft making their final approach to land are obliged to maintain minimum separation distances. These distances are fixed whatever the wind conditions. When keeping to these distances in strong headwinds longer gaps of time develop between aircraft. This means fewer flights landing per hour (reduced airport capacity), leading to delays and increased holding at busy times, which results in increased fuel burn. SESAR's time-based separation (TBS) replaces current distance separations with time intervals in order to adapt to weather conditions. It provides consistent time-based spacing between arriving aircraft in order to maintain runway approach capacity.

#### **Benefits**

- Improved airport capacity as a result of increased aircraft landing rates in strong headwind conditions
- Reduction in holding times as well as stack entry to touchdown times
- Increased situational awareness

### **13.2.3. Automated assistance to controllers for surface movement planning and routing**

Selecting the most suitable route from the departure gate to the runway or from the runway to the arrival gate depends on the airport layout, aircraft type, operational constraints such as closed taxiways, arrival routes, as well as departure planning information such as target start-up times. The SESAR surface route planning function automatically generates taxi routes which are then displayed on the controller working position. The software uses flight plans and current operational data to calculate the optimum route for each aircraft. The controller can graphically edit the route before relaying it to the pilot by voice, or, where possible by datalink.

#### **Benefits**

- Improved predictability
- Enhanced safety
- Increased capacity
- Improved taxi times resulting in reduced fuel burn

### **13.2.4. D-TAXI service for controller-pilot datalink communications (CPDLC) application**

SESAR is testing message exchanges on the airfield using controller-pilot datalink communications (CPDLC) on board modern aircraft. The service is supported at some airports with advanced controller working positions, and simulations are also underway looking at protocols and operational procedures. The delivery by datalink of information and clearances during the taxi phase is known as D-TAXI. The solution aims to reduce voice communications by exchanging non-critical message between controllers and flight crew by datalink. Radio remains available at any time and is still used on first contact with the controller for radio check and for safety or time critical clearances like line-up and take-off.

#### Benefits

- Provides reliable, repeatable message sets for non-safety critical exchanges
- Frees up congested radio channels enhances safety at busy airports
- Delivers instructions more effectively, allowing the pilot and controller to focus on other operational issues

#### **13.2.5.      *Manual taxi routing function***

Navigating the route between the departure gate and the runway can be complex and becomes harder during low-visibility conditions or at night. Presenting a graphical display of the taxi route instructions received from air traffic control provides another means for the flight crew to check they are following the right route. The on board moving map of the airfield can be overlaid with the taxi route so the pilot can see exactly where the aircraft is in relation to the cleared route. If the taxi clearance is sent via datalink, through the D-TAXI service, the corresponding message is interpreted and translated as a graphical path by the on-board moving map database. If the taxi clearance is sent via voice, the flight crew can enter it manually into the airport moving map.

#### Benefits

- Enhanced safety
- Improved predictability
- Increased efficiency in surface operations
- Reduced fuel burn and emissions

#### **13.2.6.      *Guidance assistance through airfield ground lighting***

Airfield ground lighting offers a unique opportunity to guide aircraft and vehicles around the airport. By linking the lighting infrastructure with the taxi route management system, the airport can provide an unambiguous route for the flight crew and vehicle driver to follow. The solution requires advanced technology within the lights themselves, and in the ramp control tower. The airfield lighting control system needs to turn on the lights ahead of an aircraft, and off immediately behind. To achieve this, taxiway centre line lights are automatically and progressively switched on in segments (or individually) as the aircraft (or the vehicle) moves along its assigned route. Pilots and vehicle drivers receive a single instruction to 'follow-the-greens' from ATC. If stop bars are implemented to protect no-go areas, they are also automatically commanded. The solution also relies on the surface movement guidance and control system to provide accurate aircraft position data.

#### Benefits

- Improved predictability
- Enhanced safety
- Reduced fuel burn, noise and emissions
- Increased apron throughput

#### **13.2.7.      *Virtual block control in low-visibility procedures***

Supporting controllers and flight crew is especially important in low-visibility conditions. A line of red lights, known as stop bars, are already used to prevent aircraft entering a

runway without air traffic control clearance. In addition to these physical safety nets, SESAR is advancing a novel virtual stop bar solution. During low-visibility conditions, the ground controller can introduce procedural control to maintain safe separation, requiring clearance for aircraft to enter different areas. SESAR has developed virtual stop bars to support the ground controller in providing surface movement guidance at these times, displaying red stop lights on the controller's display. The virtual stop bars can be used by the controller to reduce block sizes according to the conditions. If the airport surface surveillance system identifies an infringement, the controller's display receives an alert. These virtual stop bars are a valuable defence against aircraft and vehicles inadvertently entering an area without clearance from the ground controller. Providing alerts on the ground controller's display enhances safety.

#### Benefits

- Improved predictability
- Enhanced safety
- Reduced fuel burn and emissions

#### **13.2.8.      *Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances***

As traffic rises, airports face the challenge of more ground operations and surface traffic moving across runways, taxiways and aprons. In addition to safety initiatives driven by ICAO, a series of automation tools have been developed by SESAR partners to provide valuable safety nets in this area. As part of advanced surface movement guidance and control systems (A-SMGCS) activities, new generation automation systems have been included in validations to see how various tools can operate together to provide integrated airport safety nets. These validations assessed the relevance of alerts to tower controllers in case of conflicting clearances (e.g. line up and landing clearances given at the same time on the same runway) and in case of mobile behaviour (i.e. aircraft or vehicle) not complying with ATC instructions or procedures.

#### Benefits

- Increased situational awareness
- Improved safety in airport operations
- Enhanced safety and situational awareness

#### **13.2.9.      *Enhanced ground controller situational awareness in all weather conditions***

Ground controllers face the challenge of managing not just arriving and departing aircraft, but also guiding the service and emergency vehicles that support safe operations at the airfield. Adding surface safety nets to the controller's display offers a means to provide early warning of potential conflict situations. Developing and implementing airport safety tools is fundamental to SESAR objectives to triple capacity and increase safety by a factor of 10. Safety nets rely on information received from surface surveillance (automatic dependent surveillance – broadcast (ADS-B) messages emitted by aircraft and vehicles), flight data including clearances given, and taxi routes assigned. Built-in monitoring rules can be configured to an individual aerodrome in order to trigger alerts for the main conflict situations. Warnings can also be activated when meteorological data signals adverse weather.

#### Benefits

- Operational acceptance of airport safety nets
- Increased situational awareness in low visibility conditions
- Enhanced safety thanks to the generation of real alerts

#### **13.2.10.     *Runway status lights***

Runway incursions are among the greatest risks in airport operations today. By installing lights, which automatically alert when it is unsafe to enter a runway, airports can provide runway users with an early warning of a potential hazard. Major airports rely on surface surveillance systems such as surface movement radar (SMR) to provide the tower controller with a visual picture of surface movements in real time. Adding safety tools for controllers, for example, to highlight non-conformance alerts or route deviation, ensure safe and accurate guidance around the airport by virtue of the advanced surface movement guidance and control system (A-SMGCS). A pilot navigating to and from the runway also relies on visual signage, and this equipment can receive information at the same time as the tower, saving crucial seconds. Runway status lights (RWSL) include three types of high intensity LED lights: runway entrance lights (RELs), warning an aircraft about to enter the runway from a taxiway that the runway is not safe to enter, take-off hold lights (THLs) warning pilots that it is not safe to take-off from the runway, and runway intersection lights (RILs) to prevent flight crew and vehicle drivers from entering or crossing an active runway that is already occupied. Embedded in the pavement, the red warning lights alert the pilot or the vehicle driver the instant the runway is unsafe due to the detection of mobile behaviour by the A-SMGCS.

#### Benefits

- Enhanced runway safety
- Increased situational awareness

#### **13.2.11. Enhanced traffic situational awareness and airport safety nets for vehicle drivers**

Busy airports monitor airfield activity using a range of sensors and tracking systems. This information can also be used by vehicle drivers to improve safety. By fitting a screen in the vehicle, the driver can access an airport moving map, can see information regarding surrounding traffic, and can receive alerts if a dangerous situation arises. Warnings can include those related to possible collisions with an aircraft on a runway or taxiway, infringements of a runway, or a closed or restricted area. SESAR has carried out a series of validation exercises in different locations in various traffic and visibility conditions. Alerts were generated either by an on-board system on the dashboard, or were uplinked from the ground aerodrome surveillance system enhanced with a dedicated function calculating alert situations relevant for vehicle drivers. The trials developed the requirements for the display of information related to the surrounding traffic, including aircraft and vehicles operating on or near an active runway. The tests also established connectivity between the central system and vehicle, as well as the use of mobile devices

#### Benefits

- Increased situational awareness
- Increased safety in airport operations

#### **13.2.12. Departure manager (DMAN) baseline for integrated AMAN DMAN**

The departure manager (DMAN) tool takes into account the scheduled departure times, slot constraints, runway constraints and airport factors. In doing so, it improves traffic predictability, cost efficiency and environmental sustainability, as well as safety. By taking into consideration information such as the aircraft's readiness to leave its parking stand, runway capacity and slot constraints, tower controllers can optimise the pre-departure sequence. In order to calculate reliable sequences, DMAN needs access to accurate information about the status of individual flights and airport resources from different systems. The airport collaborative decision-making (A-CDM) platform supports this information exchange. For example, the airline or ground handler can provide the target off-block time (TOBT), while the tower controller uses tables, which generate variable taxi times to achieve the target take-off time (TTOT). Information about departure slots or calculated take-off times (CTOTs) is sourced from the Network Manager, responsible for flow control across the whole of Europe.

#### Benefits

- Improved predictability and stability of departure sequence, start-up approval time and off-time blocks
- Enhanced tactical runway scheduling
- Reduced waiting and taxi times and runway delays
- Significant reduction in fuel burn and CO2 emissions

#### **13.2.13. Pre-departure sequencing supported by route planning**

Pre-departure management delivers optimal traffic flow to the runway by factoring in accurate taxi time forecasts and route planning derived from static data. This can help to reduce waiting time at runway holding points, and improve take-off time predictability. Accuracy can be improved if the departure manager (DMAN) takes into consideration data provided by the advanced surface movement guidance and control system (A-SMGCS). This can account for where the aircraft is parked, taxi route length and tactical adjustments such as temporary restrictions. Just how much current operations – which rely on collaborative decision making to estimate taxi times – can be enhanced by access to dynamic data depends upon the individual airport and the quality of data available. SESAR trials using this dynamic route planning information resulted in more accurate calculations of the departure sequence, and improved predictability and stability of both target times and actual times. In particular, the sequence assigned to each flight for target start-up time, and for target take-off time, improved with the use of route planning information. For busy single runway airports, predictable operations result in better use of the available capacity. Trials showed that the solution leads to reduced waiting time at the runway holding point, saving fuel and improving efficiency. It also increases the accuracy of estimated taxi time and hence take-off time predictability, which in turn allows the aircraft to adhere to target take-off time. Finally, the more stable departure sequence benefits airport operations overall, and is used in turn by the Network Manager to optimise traffic flow.

##### **Benefits**

- Reduced waiting time at the runway holding point, which saves fuel and allows air navigation service efficiency
- Increased accuracy of taxi time-out predication and hence take-off time predictability, which in turn allows the aircraft to adhere to their target take-off time (TTOT)
- Provision of a more stable pre-departure sequence

#### **13.2.14. Flow-based integration of arrival and departure management**

By integrating the activities of the arrival manager (AMAN) and the departure manager (DMAN) tools, an optimisation algorithm can calculate the ideal traffic flow that takes account of both arriving and departing aircraft. Departure flow to the runway is managed by the pre-departure sequencing planning tool, while arrival flow to the runway is managed by arrival metering. Arrival and departure flows to the same runway (or for dependent runways) are integrated by setting up a fixed arrival departure pattern for defined periods. The successive pattern might be chosen by the operators or provided by an optimisation algorithm, which takes account of arrival and departure demand. The solution is an enabler for accurate runway sequencing and facilitates long-range planning such as extended arrival management. It results in increased predictability, which leads to high capacity and less fuel burn, and better coordination between controllers.

##### **Benefits**

- Increased predictability resulting in increased runway throughput
- Reduced fuel burn

#### **13.2.15. ATC and AFIS service in a single low-density aerodrome from a remote controller working position (CWP)**



Small or local airports are a lifeline for a local economy; however, they cannot always afford to operate a control tower around the clock. SESAR's remote tower services offer the means to provide air traffic services in a cost-efficient way to such airports, as well as non-towered ones. By installing sensors (mainly video cameras) around the airfield, the operator can monitor activity such as runway occupancy, weather, and visibility in real time. Data is relayed back to a remote control centre where a qualified operator is on hand to provide aerodrome flight information services (AFIS) or air traffic control services for arrivals and departures. With access to a range of visual, audio, and meteorological data, the remote facility can provide services, which may not be available onsite around the clock.

#### Benefits

- Increased cost efficiency
- Increased accessibility to and support for regional economies

#### **13.2.16. Single remote tower operations for medium traffic volumes**

Providing air traffic control services from a remote location can spread staffing costs, improve service continuity with the option to extend hours of service, and share training and support costs. The out-of-the-window view from the tower can be captured and reproduced at a remote facility where controllers can access all the information usually found in the tower. The visual reproduction can also be overlaid with information from additional sources and enhanced through technology for use in all visibility conditions. In addition, the controllers have access to all the necessary remote controls, including communications, lighting, flight data, and meteorological information. Tests have demonstrated the solution's feasibility using different technology and sensors. Sophisticated camera equipment, some sourced from the military sector, are considered in the scope of this solution; while day/night cameras, infrared, and pan tilt- zoom functions deliver the level of detail and accuracy required to safely provide ATS services. The tower-like environment at the remote facility can be enhanced with visual alerts, track labels added to flight targets, and hot spots regularly camera checked to deliver additional safety features.

#### Benefits

- Increased cost efficiency

#### **13.2.17. Remote tower for two low-density aerodromes**

Having proved controllers can provide air traffic control services to an airport remotely, SESAR validated the feasibility of providing simultaneous services to two airports from a single location. The solution offers new possibilities for small or local airports where building, maintaining, and staffing a conventional tower is unaffordable. It promises more efficient and cost-effective deployment of operational resources, improving service continuity and maintaining safety at the same time. The concept draws on a range of advanced technology, including high-definition cameras, Infrared, and pan-tilt-zoom cameras to deliver the information the controller wants to see in real time. Video camera data can be integrated with existing surveillance sources to identify and track targets.

#### Benefits

- Operational and technology-related cost efficiency

#### **13.2.18. Remotely-provided air traffic services for contingency situations at aerodromes**

Contingency towers are not new, and already operate at London, Brussels, and near completion at Budapest. They provide operational resilience and safety assurance should the primary tower be compromised. This solution brings additional technology into play, and addresses issues including accessibility, training and security to deliver more resilience and a higher efficiency in degraded situations. A remote facility offers a cost-efficient alternative to building new infrastructure onsite. It can provide air traffic control services as close to full-operating capacity as possible, and can feature additional information feeds to enhance the data available. Most importantly, it can maintain safe



flight operations, with minimum disruption to the flights operating to and from the airport affected.

#### Benefits

- Increased cost efficiency
- Improved resilience in degraded situations

#### **13.2.19. A low-cost and simple departure data entry panel for the airport controller working position**

Many airports in Europe, particularly regional and small airports, are not equipped with electronic flight data processing systems (eFDPs) but rely on paper flight strips and voice communications. As a result, the integration of these airports into the air traffic management network is often limited and leads to a lack of predictability of air traffic from these airports. SESAR has developed affordable ways to link these airports to the wider network. The use of a simple airport departure data entry panel (ADDEP) provides a low-cost solution to compute and share aircraft electronic pre-departure data across the air traffic management network, between the tower and approach controllers, as well as the tower and the Network Manager. Trials carried out at a small airport tested a standalone panel, which the controllers used to input data such as pushback clearance, taxi and cleared for take-off. This ADDEP then generated departure messages, which could be used to update the local flow management centre and the Network Manager.

#### Benefits

- Significant improvement in traffic predictability
- Increased network capacity
- Better runway configuration and management

#### **13.2.20. Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP)**

The AOP is a single, common and collaboratively-agreed rolling plan for an individual airport. The AOP relies on information from different players including airlines, ground handlers, air traffic control, security, emergency services, meteorology and airport management. Set against specific performance targets, the airport monitors the progress of the plan and mitigates the impact of any deviations that may occur. Daily airport operations are managed by the APOC, which can be a physical facility or a virtual collaboration between stakeholders. The alignment between planned and executed operations is continuously monitored, with changes being made to the AOP as required. As stakeholders update their intentions, or accurate flight progress information is received, the AOP is refined and used to manage resources and coordinate operations. Integration with the NOP extends the planning activities to include air traffic demand and improved target time coordination. The aim with this solution is to provide processes and tools to maintain airport performance in all operating conditions, and to share information with the wider network. Two principal services are provided by this solution: to establish appropriate performance goals and to monitor the performance during the execution timeframe. Ultimately the AOP and APOC make airports more resilient to disruptions by enhancing the common situational awareness of ATM stakeholders through the sharing of real-time information.

#### Benefits

- Enhanced predictability
- Improved airport resilience/limiting capacity reduction in degraded situations

#### **13.2.21. De-icing management tool**

The SESAR de-icing management tool (DMIT) refers to a system capable of improving the predictability of aircraft de-icing operations at European airports by taking data inputs from meteorological service providers and involving the relevant airport

stakeholders. The solution increases the accuracy of information related to when the procedure is going to take place, how long it will take and when the aircraft will be ready to taxi for departure, which is currently calculated by predetermined estimates. The solution means that air traffic controllers no longer need to work without situational awareness of de-icing activities and needing to make their own estimates of when aircraft are ready for departure. The solution envisages that de-icing operations are no longer characterised by the A-CDM concept as 'adverse conditions', i.e. a state that is in need of collaborative recovery procedures, but rather a part of normal operations in the winter period.

#### Benefits

- Improved situational awareness of aircraft de-icing operations
- Increased predictability

### **13.3.        *Advanced air traffic services***

#### **13.3.1.        *Extended arrival management (Extended AMAN) horizon***

Today, arriving traffic is managed and sequenced in the airspace close to the airport. Faced with increasing traffic, airports are looking for ways to overcome congestion and reduce the need for holding. Planning arrivals into a busy airport an hour or more before touchdown cuts down holding time, reduces noise and saves fuel. Extended-AMAN (E-AMAN) allows for the sequencing of arrival traffic much earlier than is currently the case, by extending the AMAN horizon from the airspace close to the airport to further upstream and so allowing more smooth traffic management.

Controllers in the upstream sectors, which may be in a different control centre or even a different functional airspace block (FAB), obtain system advisories to support an earlier pre-sequencing of aircraft. Controllers implement those advisories by, for example, instructing pilots to adjust the aircraft speed along the descent or even before top-of-descent, thus reducing the need for holding and decreasing fuel consumption. E-AMAN is supported by sharing the airport's arrival management information with upstream sectors in real time. All parties share the same information using a system-wide information management (SWIM) service.

#### Benefits

- Improved operational efficiency by reducing holding times
- Improved operational efficiency by reducing fuel burn and emissions
- Efficiency in terms of air navigation service provision
- Improved safety and quality of service

#### **13.3.2.        *Point merge in complex terminal airspace***

The point merge route structure provides a more efficient way to vector aircraft down to the final approach path. It allows departure and arrival streams to operate independently without risk of conflict, and delivers more predictable arrival times. The concept is simple. By designing standard sequencing legs ahead of the final approach point, aircraft can be guided along shorter or longer distances in order to reach a single entry point. For a busy terminal area controllers can start to sequence arrivals at an earlier stage, while pilots receive fewer interventions so can fly a more efficient approach path down to the runway.

#### Benefits

- Increased capacity in the terminal airspace
- Improved safety levels
- Improved air navigation service provision
- Reduced fuel consumption and emissions

#### **13.3.3.        *Arrival management (AMAN) and point merge***

Point merge not only delivers a more efficient arrival route structure in the terminal airspace, it can be applied to the extended terminal airspace area for pre-sequencing traffic. SESAR has developed point merge for this environment to enable the arrival manager (AMAN) to establish a more predictable arrival sequence. Integrating and optimising arrival streams contributes to the overall arrival management process both in terms of aircraft efficiency and airport operations. It is this predictability, which can significantly improve capacity in dense and complex terminal airspace, and avoid unnecessary holding. The solution is composed of a point merge system coupled with an arrival management tool that provides sequencing support based on trajectory prediction. Rather than entering holding patterns, aircraft in the extended terminal area enter performance based navigation (PBN) routes referred to as point merge legs, where they fly briefly in a level-off lateral holding situation where the distance to the merge point remains constant. When the spacing with the preceding aircraft is attained, the controller will instruct the next aircraft on the leg to turn direct to the merge point. Unlike conventional traffic streams, which are individually vectored, the turn the aircraft needs to perform in the point merge leg is always the same, which simplifies the controller's tasks. The flight crew's task is also simplified by the use of this standardised manoeuvre, which is predictable and repeatable.

#### Benefits

- Better management of human resources
- Improved pilot situational awareness through the application of more standardised procedures
- Enhanced safety
- Reduced noise impact

#### **13.3.4. Continuous descent operations (CDO) using point merge**

Aircraft engines have become quieter but an aircraft's flight path can also help reduce noise levels by following a smooth descent down to the runway threshold rather than a conventional stepped approach. Up until now, these continuous descent operations (CDOs) have been restricted to low and medium traffic density environments due to their impact on airport capacity. By combining it with point merge techniques, SESAR has extended the solution so it can be applied to high-density traffic environments at a lower altitude and in a small and very constrained airspace.

During the validation of the solution, aircraft were vectored to a common merge point from where they followed a single air navigation trajectory (RNAV) procedure to intercept the instrument landing system (ILS). Since all sequencing procedures were completed by the merge point, from there pilots could follow an unconstrained descent path. In this procedure, controllers do not need to issue any level-off clearances after the merge point, while fewer level-offs are required earlier during the vectoring to merge point procedure. This results in higher profiles in the vicinity of the airport.

#### Benefits

- Reduced fuel burn and emissions
- Reduced environmental impact of airports on their neighbouring communities
- Noise reduction

#### **13.3.5. Precision area navigation (P-RNAV) in a complex terminal airspace**

Equipped to fly to within an accuracy of one nautical mile (NM), modern aircraft have the capability to follow very flexible routes, for example reducing noise impact on populated areas and easing bottlenecks. This navigation capability is especially useful in busy terminal airspace, where the increased accuracy allows more approach paths, which can release capacity, reduce holding and cut emissions. Introducing precision area navigation (P-RNAV) procedures improves the design and organisation of the airspace allowing the aircraft's on-board navigation system to fly optimised flight paths. P-RNAV supports more

efficient continuous descent approaches and continuous climb departures in place of traditional stepped flight profiles issued by a controller. P-RNAV also supports curved approach paths, which can avoid complex interaction between inbound and outbound traffic, heavily populated areas, and can reduce track miles for inbound aircraft.

#### Benefits

- Enhanced safety thanks to better precision
- Reduced fuel burn and emissions
- Improved air navigation service provision

#### **13.3.6. Optimised route network using advanced required navigation performance (RNP)**

Aircraft flying advanced A-RNP procedures can be relied on to stay within one mile on either side of the nominal flight path whether flying a straight leg or a turn. In practical terms, this means that controllers can have greater confidence in the track-keeping performance of the aircraft and this greater confidence translates into being able to place routes closer together. Nominal RNP1 routes can be designed as close as seven nautical miles (NM) in en-route sectors and as close as five NM in terminal airspace. Advanced RNP (A-RNP) routes support precise flight profiles such as spaced parallel routes, fixed radius transition (FRT) and tactical parallel offset (TPO).

#### Benefits

- Enhanced safety
- Improved operational efficiency by reducing fuel burn and emissions
- Improved air navigation service provision

#### **13.3.7. Enhanced terminal operations with RNP transition to ILS/GLS**

Modern flight management systems have the ability to fly a repeatable curved trajectory, known as radius-to-fix (RF), which some airports are adding to their arrival and departure procedures. SESAR has worked on the introduction of these turns by supporting the design of new procedures that connect the route structure to the final approach path. Final approach guidance may be provided by existing ILS, but for GBAS-equipped airports they may also be provided by new ground-based augmentation system (GBAS) landing systems (GLS), using constellations such as Galileo.

#### Benefits

- Improved fuel efficiency
- Increased runway throughput (GBAS)
- Enhanced safety

#### **13.3.8. Enhanced terminal operations with RNP transition to LPV**

This SESAR solution defines required navigation performance (RNP) transitions to localiser performance with vertical guidance (LPV) to enhance terminal operations. SESAR supports wider use of advanced RNP to enhance terminal area operations. SESAR's advanced approach procedures with vertical guidance (APV) include the smooth transition from RNP arrival routes into RNP approach flight paths with barometric descent guidance that then transition to the LPV approach segment with geometric descent guidance. The transitions may include radius-to-fix (RF) turns that leave the aircraft aligned with the runway as close as three nautical miles (NM) before the threshold. From that point, the satellite-based guidance allows the pilot to descend safely down to a decision height of 200 ft., which is equivalent to ILS Cat I, minima. Advanced APV allows increased flexibility in planning arrival paths in terminal airspace, making it possible to design procedures that control the noise impact of the airport or reduce track miles to cut fuel consumption.

#### Benefits

- Increased flexibility in the design of TMA route layouts and landing procedures, which result in fuel savings and reduced noise impact on the communities neighbouring the airport
- Increased predictability
- Improved safety

#### **13.3.9. Approach procedures with vertical guidance**

LPV procedures do not require any new equipment at the airport, which makes them an ideal low-cost alternative to increase access to secondary airports that may not be ILS-equipped on all runways. For ILS-equipped runways, the new approach design may be useful either to shorten the flightpath for certain traffic flows or simply to overlay the existing ILS and be used as a fall-back procedure in case of airborne or ground ILS equipment malfunction.

Benefits

- Improved access to airports in all weather conditions, without the need to install ground equipment
- Improved descent profile and reduced track miles, resulting in reduced fuel burn
- Reduced noise footprint
- Improved safety

#### **13.3.10. Optimised low-level instrument flight rules (IFR) routes for rotorcraft**

This SESAR Solution enables the design of IFR routes at very low level, based on the ability of suitably-equipped rotorcraft to navigate very accurately using global navigation satellite systems (GNSS) using the European satellite-based augmentation system (SBAS): the European Geostationary Navigation Overlay Service (EGNOS). Routes are designed to an enhanced required navigation performance (RNP) standard that allows an optimised use of the airspace within medium and dense/complex TMAs. Routes are designed to either RNP 1 or RNP 0.3 depending on the altitude and degree of precision needed as a result of neighbouring procedures, airspace and/or terrain.

Benefits

- Increases access to TMAs for rotorcraft
- Increases safety and resilience of rotorcraft operations
- Reduced noise

#### **13.3.11. Arrival management into multiple airports**

This SESAR solution coordinates traffic flows into multiple airports by means of a centre manager (CMAN). The solution operates in conjunction with the arrival management systems of the different airports to develop optimum arrival streams, based on balancing the demand and capacity. The CMAN uses airport data including predicted departure times and the extended arrival management horizon to calculate the most efficient arrival streams.

Benefits

- Enhanced predictability
- Improved fuel efficiency
- Better use of available capacity
- Enhanced safety

#### **13.3.12. Controlled time of arrival (CTA) in medium density/ medium-complexity environments**

Controlled time of arrival (CTA) is a time constraint defined by air traffic control that allows an aircraft to self-manage its speed to arrive at a specific time at a defined point associated with an arrival runway. The controller calculates the CTA as part of the arrival management process and relays this information to aircraft equipped with this advanced navigation capability. While arrival management systems are not able to evaluate the most fuel-efficient strategy for each individual aircraft, each aircraft's flight management system will optimise the flight speed according to aircraft type and wind conditions.

Benefits

- Improved fuel efficiency per CTA flight
- Enhanced predictability
- Improved flight crew situational awareness

#### **13.3.13. Sector team operations - en-route air traffic organiser**

In this framework, the SESAR solution is a medium-term conflict detection (MTCD) tool that allows controllers to filter aircraft and extrapolate their future positions. The tool is based on providing assistance to controllers particularly when faced with stress, fatigue or other disturbing agents. The solution does a number of things to help the controller. It shades out – according to pre-determined criteria – flights, which are not relevant to a particular situation. It provides visual aids to help the controller schedule tasks. It also extrapolates the predicted trajectory of specific flights to aid the controller to identify potential conflicts well in advance. In addition, it provides geographical markers to provide the controller with task reminders at specific locations.

Benefits

- Effective management of team operations
- Improved monitoring of traffic as well as information and task sharing
- Increased en-route airspace capacity

#### **13.3.14. Multi-sector planning**

The new operating procedures are a direct result of enhancements to the planning tools, such as the aforementioned solution, which improve the efficiency of the planning and decision-making process. They are not expected to be applicable to all sectors at all traffic levels, but a number of sectors can be combined in this way and operate efficiently at reasonably high traffic levels. A further phase of solution development is extending the new team structure beyond one planner supporting two tactical controllers, to several tactical controllers under the responsibility of a single planner controller. This evolution will require developing the way in which boundaries are defined between planning and tactical control.

Benefits

- Improved task sharing
- Better distribution of human resources
- Improved cost efficiency due to flexibility in sourcing and deployment of human resources

#### **13.3.15. Enhanced tactical conflict detection & resolution (CD&R) services and conformance monitoring tools for en-route**

Reliable and accurate conflict detection and resolution services lead to better decision making and fewer tactical interventions by controllers. This SESAR Solution consists of innovative approaches that provide the en-route controller with two separation provision services: First, an enhanced monitoring conformance service (MONA) for both tactical and planning controllers. Compared to the existing MONA, this SESAR Solution includes a new alert to take into account lateral deviation and the rate change monitoring in climbing and descending phase to minimize false alerts. Second, a conflict detection and resolution service fully dedicated and designed for the tactical controller with a conflict detection service down to flight level 100. This service is based on effective clearances

and specific ergonomics and use developed for the tactical controller, but also available and usable for the planning controller

#### Benefits

- Improved safety
- Optimised air navigation service provision
- Improved capacity
- Increased cost efficiency

#### **13.3.16.    *User-preferred routing***

The results of the SESAR validation exercise served to identify a list of direct routes within one air traffic service unit that could be implemented. They also showed the maturity of the solution, which represents the first step towards the more advanced concept of free route operations. The Maastricht Upper Area Control centre now offers more than 250 user-preferred routes and has recorded an average 7 % reduction in flight distance flown – or two minutes less flight time - by participating aircraft, while lower fuel consumption has seen emissions fall between 6 and 12%.

#### Benefits

- Improved flight efficiency within one air traffic service unit
- Reduced average flown distance and reduced flight time
- Maintained air navigation service provision, despite capacity increase
- Reduced fuel burn and emissions
- Maintained levels of safety

#### **13.3.17.    *Free route through the use of direct routing***

Direct routing allows airspace users the possibility to plan a route close to their preferred flight path by selecting a direct route - connecting published waypoints - without the need for the intermediate points to be present in the current fixed-route network. The extension of direct routes across flight information regions and national boundaries require appropriate airspace changes, as well as new flight data processing systems from airspace users. Advanced flexible use of airspace at the regional scale supports the use of direct routing operations.

#### Benefits

- Increased airspace capacity
- Improved operational efficiency
- Reduced fuel burn and emissions

#### **13.3.18.    *Free route through the use of free routing***

The solution allows airspace users to plan trajectories, without reference to a fixed route or published direct route network. In doing so, it provides them with significant opportunities to optimise their respective flights in line with individual operator business needs and military requirements.

#### Benefits

- Increased airspace capacity
- Improved operational efficiency
- Reduced fuel burn and emissions

#### **13.3.19.    *Enhanced short-term conflict alert (STCA) for terminal manoeuvring areas***



Validation exercises looked at enhanced STCA solutions to reduce the number of false and nuisance alerts compared to existing technologies, while maintaining the detection of genuine alerts. This is beneficial for flight safety, as it helps controllers focus on issues such as conflict risks or resolution advisories. The enhanced algorithms developed for the STCA prototype led to more precise warnings and fewer false and nuisance alerts when compared against existing STCA technology.

#### Benefits

- Identification of conflicts, both en-route and in the terminal area
- Reduced false alert rate while maintained genuine alert rate and warning times are maintained
- Significant increase in safety of flight especially during complex operations

#### **13.3.20.    *Enhanced short-term conflict alerts (STCA) with downlinked parameters***

Aircraft already transmit enhanced surveillance data using Mode S. In this SESAR solution, two Mode-S derived parameters were incorporated into the STCA logic: selected flight level and track angle rate. The former prompts the system to check if the aircraft intends to climb or descend to a certain flight level even before it begins the manoeuvre. This can detect an unsafe clearance given in error by the controller, or controller-pilot misunderstandings in radio transmissions, such as read back errors or instructions copied by a different aircraft. The latter - track angle rate - gives a better anticipation of how an aircraft will turn, and applies particularly in terminal airspace.

#### Benefits

- Enhanced safety through reduced false alert rates and improved warning times of conflicts between flights
- Improved operational efficiency
- Increase of controller's situational awareness

#### **13.3.21.    *Enhanced airborne collision avoidance system***

SESAR partners conducted validation exercises that replicated the environment in which ACAS is being operated, and used different configurations to test the application of the new altitude capture rule compared with existing operations. The scenarios included testing aircraft in close encounters, where there is an actual risk of mid-air collision, and in day-to-day encounters, in which the aircraft are not necessarily on a close-encounter course but where trajectories may trigger a conflict alert. The tests looked at safety, pilot acceptance, compatibility with air traffic control, and trajectory modification, to see if the new law improved the current situation.

#### Benefits

- Safety levels are maintained
- ACAS operations are less disturbing for air traffic management and pilots
- Increased air navigation service provision
- Resolution advisories are more consistent
- Shorter response time for resolution advisories in general

### **13.4.            *Optimised ATM network services***

#### **13.4.1.        *Initial collaborative network operations plan(NOP)***

The SESAR Solution extends the collaborative NOP information structure to enable more data exchanges between the Network Manager and other partners in order to deliver greater operational efficiency. Additional automation tools support the process, and assist decision making and performance monitoring. The concept also uses system-wide information management (SWIM) to allow shared operational real-time decision making. The SESAR solution addressed three main aspects: the airport operations plan (AOP)-



NOP integration, the meteorological status monitoring and the network performance monitoring.

#### Benefits

- Increased ATC network capacity
- Enhanced predictability
- Improved planning allowing for optimised routes
- Enhanced safety

#### **13.4.2.      *Automated support for dynamic sectorisation***

This SESAR automated solution considers the traffic needs, and groups or ungroups airspace sectors to match capacity with evolving demand. The support tool is used by the supervisor to determine sector planning on the day of operations and to manage staff resources accordingly. The result is better use of airspace and human resources, improved safety due to early management of constraints, and fewer delays.

#### Benefits

- Improved safety due to increased situational awareness of supervisors
- Increased capacity due to better use of available resources, both human and airspace
- Reduced saturation periods and flight delays
- Increased cost efficiency

#### **13.4.3.      *Variable profile military reserved areas and enhanced civil-military collaboration***

This solution offers greater flexibility by allowing dynamic airspace management in all phases of ATM operations, from initial planning through to the execution phase, taking into account local traffic characteristics. The solution includes support tools, operational procedures and processes for real-time airspace status data exchange and for managing variable profile areas (VPA). Planning operations can be enhanced by sharing airspace information in real time and supporting the collaborative decision-making process between the Network Manager, civil and military authorities, and airspace users. The aim is to achieve greater dynamic airspace management, accommodating local and network needs.

#### Benefits

- Increased airspace capacity
- Optimised trajectories, thereby reducing track miles
- Improved safety

#### **13.4.4.      *Automated support for traffic complexity detection and resolution***

SESAR is replacing today's non-integrated tools with advanced software that can assess traffic demand and complexity based on continuously updated information from multiple sources. By applying predefined complexity metrics, FMPs at local level can take timely action to adjust capacity in collaboration with the Network Manager and airspace users. The result is more predictable traffic flow, fewer delays and enhanced safety.

#### Benefits

- Increased ATC capacity
- Improved punctuality
- Increased cost efficiency
- Enhanced safety

- Reduced fuel and emissions

#### **13.4.5.      *Advanced short-term ATFCM measures (STAMs)***

SESAR has developed advanced STAMs through sharing information between the Network Manager and area control centres, which only impose a wider range of measures as and when necessary. Through close cooperation between different actors, it is possible to target individual flights with a STAM measure, such as a minor ground delay, flight level cap, or minor re-routing.

Benefits

- Better use of airspace capacity in terminal and en-route airspace
- Increased cost efficiency
- Improved situational awareness of the European network

#### **13.4.6.      *Calculated take-off time (CTOT) and target time of arrival (TTA)***

The solution aims at complementing departure regulations, such as the calculated take-off time (CTOT), with the dissemination of locally-generated target times, over the hotspot. Each airport collaborates with terminal area control to develop its own strategy to allocate the available landing capacity. Strategies are likely to take into account airspace users' input, the consistency of flight plans with seasonally-allocated airport slots, arrival route and runway allocation, or gate and connection management. This collaborative process contributes to a more coherent approach to demand regulation, which is expected to result in a reduced number of knock-on delays.

Benefits

- Improved information sharing
- Enhanced predictability
- Improved situational awareness
- Increased capacity

#### **13.4.7.      *Enhanced air traffic flow management (ATFM) slot swapping***

The SESAR solution enhances slot swapping functionalities by making it possible to swap pre-allocated slots with allocated slots or carry out multiple swaps for a single flight. These functionalities allow airlines to swap between long-haul and short-haul flights, or split the delay assigned to one flight between a maximum of three flights.

Benefits

- Improved network performance (management and capacity)
- Improved environmental performance

#### **13.4.8.      *User-driven prioritisation process (UDPP) departure***

A full-scale demonstration at a major European hub introduced the SESAR tool as part of the airport's existing pre-departure sequencing process. The Departure Flexibility (DFlex) project allowed airlines to re-order departures based on their operational requirements while still early in the planning stages. It also included a 'ready-to-depart' functionality to support an immediate swap for a flight that is ready for start-up. Participating airlines were given the opportunity to agree to a new target start-up approval time (TSAT) with air traffic control to optimise their schedules.

Benefits

- Reduced airline delay costs in case of disrupted situations, without jeopardising airport and network performance
- Increased flexibility for airlines
- Improved environmental performance

### **13.5.      *Enabling aviation infrastructure***

#### **13.5.1. Initial ground-ground interoperability**

The solution is based on a secure system-wide information management (SWIM) technical infrastructure (known as the SWIM blue profile) supporting the concept of the 'flight object' which is a single entity holding the most up-to-date information about a flight. The system allows controllers to conduct silent coordination between adjacent units. In this way, all air traffic control facilities hold a consistent view of the flight at all times, which supports seamless cross-border operations, including cross-border free route operations.

Benefits

- Increased and easier access to information sharing
- Support standards update in preparation for deployment

#### **13.5.2. Extended projected profile (EPP) availability on the ground**

The initial trajectory information sharing solution is based on the aircraft downlinking trajectory information directly from the FMS to the ground systems via an updated standard for the automatic dependent surveillance contract (ADS-C) that is used today exclusively for oceanic and remote operations. The newly developed standard is called ATN Baseline 2 and targets all operations. It allows the i4D FMS to downlink the extended projected profile (EPP), which contains an updated FMS route prediction. The data in the new standard is much more detailed than in the current ADS-C reports used in oceanic airspace; it includes, for example, the predicted aircraft weight, as well as the predicted horizontal and vertical speeds on up to 128 future waypoints along the route.

Benefits

- Increased ground situational awareness resulting in increased predictability

#### **13.5.3. AOC data increasing trajectory prediction accuracy**

Access to flight planning data enables air traffic control to create more accurate trajectory predictors (TP) based on the intentions of the aircraft. The TP are used by advanced controller tools to detect potential conflicts and to develop efficient arrival and departure streams. Eventually, when new datalink communications are universally applied, trajectory information will be exchanged directly between the aircraft and the ground, anticipated from 2025 onwards.

Benefits

- Increased predictability
- Increased safety

#### **13.5.4. Extended flight plan**

The extended flight plan (EFPL) goes beyond the ICAO minimum requirements for aircraft flight plans, which were updated in 2012, with yet more operational data. In addition to trajectory data and aircraft performance data (compared to the ICAO flight plan), a key part of the concept allows for applied airspace management constraints and accepted trajectories to be sent from the Network Manager to the airspace users.

Benefits

- Improved network predictability
- Enhanced safety
- Improved performance of conflict detection and The extended flight resolution tools

#### **13.5.5. Digital integrated briefing**

Aircraft are increasingly equipped with electronic flight bag (EFB) devices, which support pre-flight briefing to the pilot and on the ground through provision of flight documentation. The pre-flight briefing could take place directly on the EFB, receiving digital briefings from the ground and updated over a datalink during the flight. Retrieval of the digital aeronautical data, including NOTAM and MET data, is enabled by means of system-wide information management (SWIM) and digital NOTAM.

Benefits

- Enhanced information sharing
- Increased cost efficiency through improved service provision
- Improved situational awareness

#### **13.5.6. Meteorological information exchange**

Meteorological information is currently available in several message formats and also in the form of maps or charts and plain text. Although end users are accustomed to these formats, they limit the opportunity to use the data effectively, for example to prioritise key information, or highlight relevant weather phenomena. Access to more precise weather data can assist decision making when it comes to flight planning, resource planning, and route planning, and can help to avoid unnecessary delay.

Benefits

- Improved safety
- Improved planning, leading to fuel reduction
- Increased cost efficiency through improved service provision

#### **13.5.7. Initial system-wide information management (SWIM) technology solution**

The aim of SWIM is to provide information users with relevant and commonly understandable information. It does not refer to a single solution or technology, but rather a global level of interoperability and standardisation that enables users and providers to exchange data without having to use different interfaces or protocols. It is based on service-oriented architecture and open and standard technologies. It introduces a totally new way of working that sits comfortably in a cloud environment.

Benefits

- Increased cost efficiency and easily accessible information sharing
- Improved contextual awareness
- Improved collaborative decision making

#### **13.5.8. ACAS ground monitoring and presentation system**

The system includes the potential to provide real-time airborne data to ground-based safety nets. For ACAS RA monitoring, the ground station is extended to be able to receive 1030 MHz messages exchanged between ACAS equipped aircraft and the RA broadcast that can provide information on the presence of an RA.

Benefits

- Enhanced safety

#### **13.5.9. Extended hybrid surveillance**

The technical solution consists of an enhanced TCAS capability, adding passive surveillance methods and reducing the need for active Mode-S interrogations. By making fewer active interrogations, this solution allows the aircraft to significantly reduce frequency usage.

Benefits

- Reduced risk of radar information loss due to overloaded frequency band

#### **13.5.10. Aeronautical mobile airport communication system (AeroMACS)**

The aeronautical mobile airport communication system (AeroMACS) offers a solution to offload the saturated VHF datalink communications in the airport environment and support new services. The technical solution AeroMACS is based on commercial 4G technology and uses the IEEE 802.16 (WiMAX) standard. Designed to operate in reserved (aeronautical) frequency bands, AeroMACS can be used for air navigation service providers (ANSPs), airspace users and airport authority communications, in compliance with SESAR's future communication infrastructure (FCI) concept.

Benefits

- Increased capacity for information and communications exchanges
- More efficient airport surface operations with increased safety and security levels
- Increased cost efficiency, thanks to synergies and sharing of infrastructure between actors, thereby lowering costs

#### **13.5.11. Air traffic services (ATS) datalink using Iris Precursor**

The Iris Precursor is designed to exploit an opportunity to deploy an aviation communications service based on the existing SwiftBroadband (SBB) satellite network from Inmarsat. The aim is to augment the existing VHF datalink (VDL) capability in Europe in order to increase reliability and capacity, and help establish satellite communications as a key component in the future ATM communications landscape. This solution also offers an alternative datalink option for aircraft already equipped with SATCOM systems.

Benefits

- Enabler for initial i4D operations

#### **13.5.12. ADS-B surveillance of aircraft in flight and on the surface**

The SESAR solution consists of ADS-B ground station and surveillance data processing and distribution (SDPD) functionality. The solution also offers detection and mitigation techniques against deliberate spoofing of the ground system by outside agents. These techniques can also be used to cope with malfunctioning of avionics equipment. SESAR has contributed to the relevant standards, such as EUROCAE technical specifications, incorporating new functionalities developed for the ADS-B ground station, ASTERIX interface specifications as well as to the SDPD specifications.

Benefits

- Enabler for surveillance infrastructure rationalisation

#### **13.5.13. Composite cooperative surveillance automatic dependent surveillance – broadcast/Wide area multilateration (ADS-B/WAM)**

By allowing the use of ADS-B data that has been validated against data derived in parallel by a WAM system, the system can help to reduce the number of interrogations and number of replies and therefore reduce the 1030/1090 MHz radio frequency (RF) load and improve spectrum efficiency. It achieves this through the integration of validated data items into the WAM channel, thereby preventing a need to re-interrogate the data item.

## Benefits

- Improved cost efficiency
- Improved security

## **14. ANNEX D: BIBLIOGRAPHY**

### **14.1.       *Legislation***

- 1) COUNCIL REGULATION (EC) No 219/2007 of 27 February 2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR)
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#### **14.5. SJU Planning and Management Documents**

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- 70)Job Description: Chief Strategy & External Affairs
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## 15. ANNEX E: INTERVIEWS

Name	Organisation	Role in SESAR	Date
Florian Guillermet	SJU	Executive Director	24 <sup>th</sup> April 8 <sup>th</sup> March 1 <sup>st</sup> June
Peter Hotham	SJU	Deputy Executive Director	2 <sup>nd</sup> March 31 <sup>st</sup> May
David Bowen	SJU	Chief ATM	2 <sup>nd</sup> March 31 <sup>st</sup> May
Benoit Fonck	SJU	Chief Development & Delivery	2 <sup>nd</sup> March 30 <sup>th</sup> May
Micheal Standar	SJU	Chief Strategy & External Affairs	2 <sup>nd</sup> March
José Calvo Fresno	SJU	Chief Administration Affairs	2 <sup>nd</sup> March 30 <sup>th</sup> May
Alain Siebert	SJU	Chief Economist & Master Planning	1 <sup>st</sup> March
Maurizio Casteletti	EC	Head of SES Unit	1 <sup>st</sup> March
Marco De Sciscio	EC	SESAR Policy Officer	1 <sup>st</sup> March
Octavian Vasile	EC	SESAR Policy Officer	1 <sup>st</sup> March
Nicolas Warinsko	SDM	Deputy Executive Director	2 <sup>nd</sup> March
Russel Dudley	ERA	Admin Board Alternate	7 <sup>th</sup> March
Vincent De Veroy	ASD	Admin Board Member	7 <sup>th</sup> March
Luc Laveyne	ACI	Admin Board Member	8 <sup>th</sup> March
Panos Siliotis	ACI	Admin Board Alternate	8 <sup>th</sup> March
Giovanni Russo	SEAC	Admin Board Member	8 <sup>th</sup> March
Thomas Buchanan	Skyguide	Admin Board Member	8 <sup>th</sup> March
Dirk Kugler	AT-ONE	Admin Board Member	9 <sup>th</sup> March
Miriam le Fevre Hansen	COOPANS	Admin Board Member	9 <sup>th</sup> March
Ralph Bertsch	DLR	Admin Board Member	20 <sup>th</sup> March
Stefano Porfiri	Leonardo	Admin Board Member	22 <sup>nd</sup> march
Peter Hecker	TUB	Scientific Committee	27 <sup>th</sup> March
Philippe Merlot	EUROCONTROL	Admin Board member	31 <sup>st</sup> May
Jean Marion Marinescu	EP	TRAN Rapporteur for SES	June

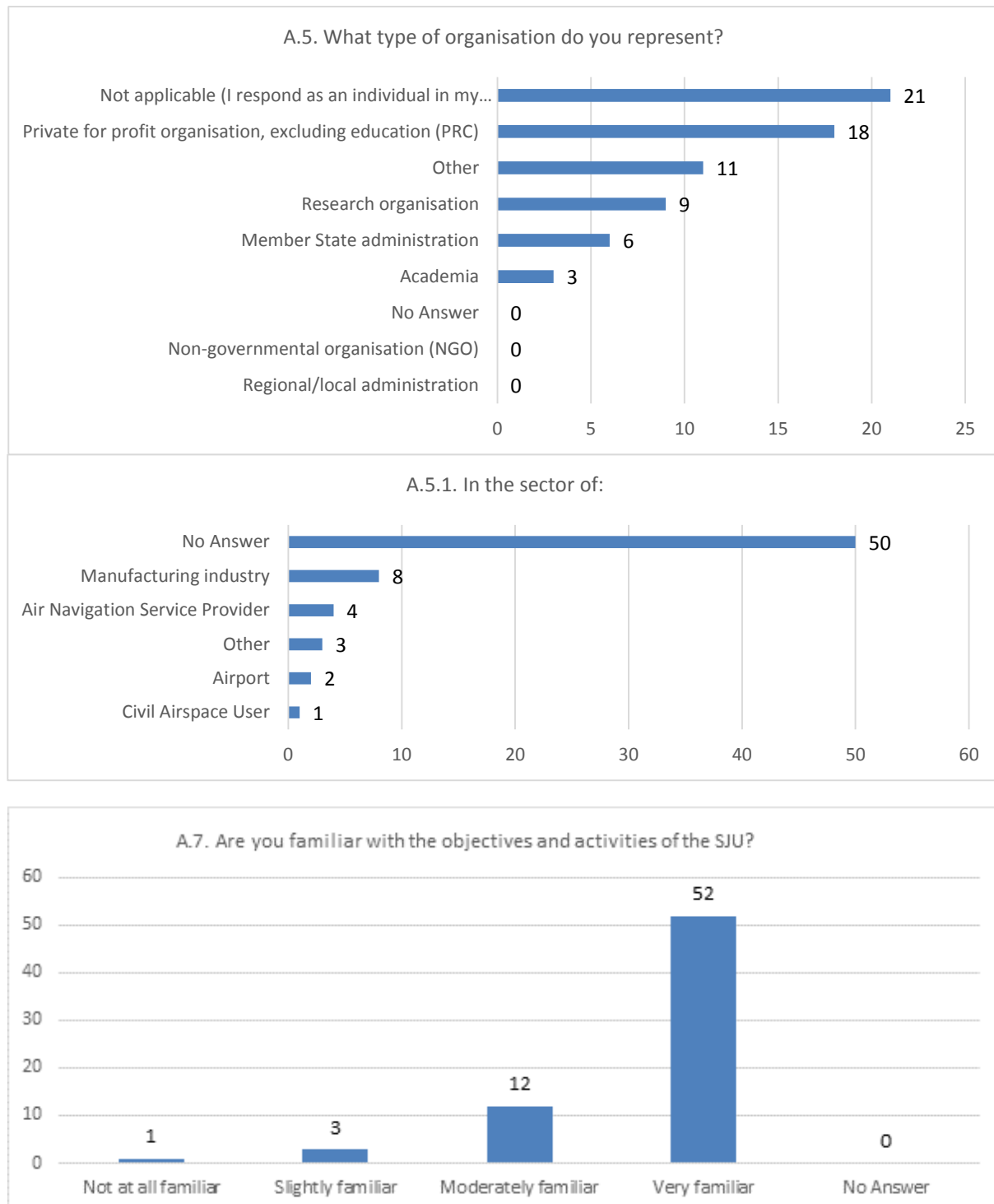
## 16. ANNEX F: RESULTS OF THE STAKEHOLDER SURVEY

### 16.1. Context

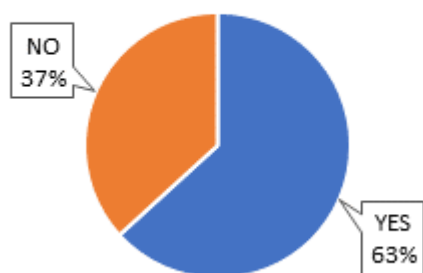
The European Commission launched an on-line public survey in December 2016 covering all seven Joint Undertakings. 68 respondents replied to the questions relating to SESAR (32 responded in a personal capacity and 36 in a professional capacity (for example on behalf of their organisation). Only 4% of responses represented SMEs.

### 16.2. Part A: Respondents, Familiarity with SESAR and Role in SESAR

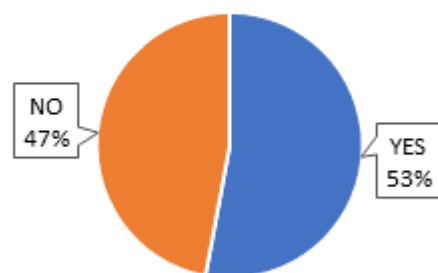
Charts below represent the type and sectors of organisations presented in the survey:



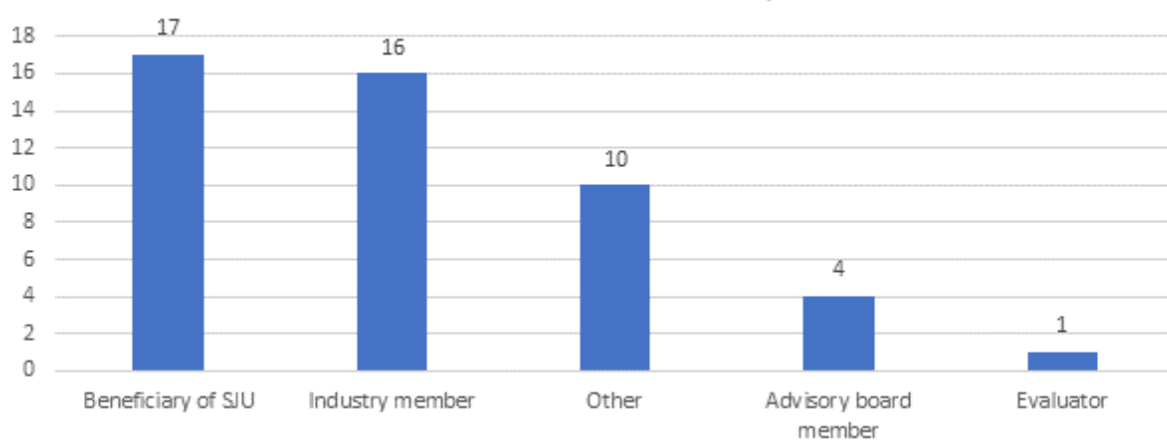
A.8. Have you applied for funding from SJU?



A.9. Are you directly involved with the SJU?

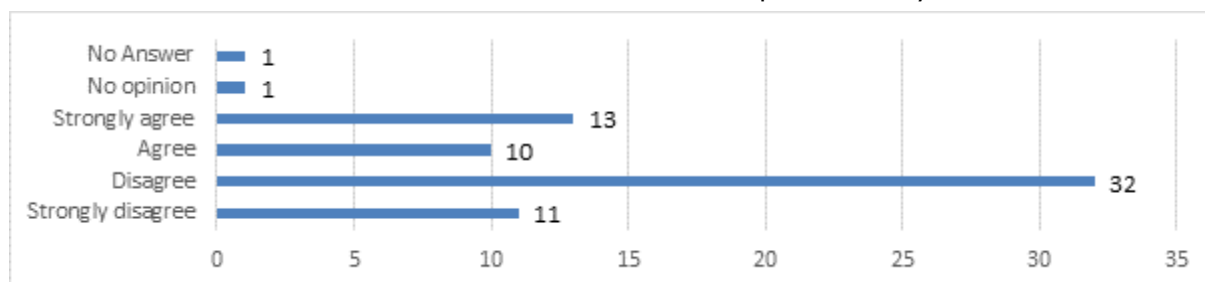


A.9.1. You are involved with the SJU, as:

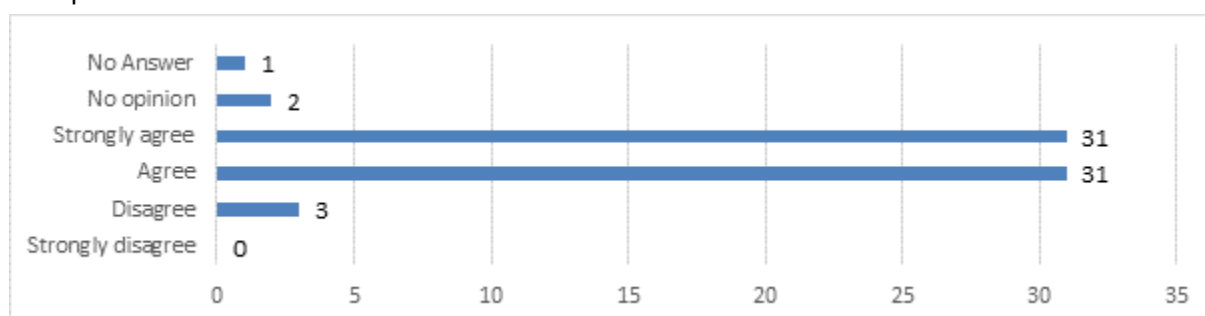


### 16.3. Part B: European Added Value

B.1 In your view, could the ATM industry along with other possible actors at national level but without the involvement of the EU, develop innovative and interoperable solutions in order to modernise and harmonise the European ATM system?



B.2. Do you agree with the EU cooperating with industry in the context of a public-private partnership so that the ATM research brings better results to all ATM stakeholders in Europe?



B.3. What is the European added value of this public-private partnership?

Value	Responses					
	Not important at all	Not important	Important	Very Important	No opinion	No answer
B.3.1. Better use of available funding	2	10	19	<b>31</b>	0	6
B.3.2. Integration of European research	1	1	23	<b>36</b>	1	6
B.3.3. More cross border cooperation	2	1	16	<b>41</b>	2	6
B.3.4. More cross-sector/interdisciplinary/ multi-stakeholder cooperation	2	3	22	<b>34</b>	1	6
B.3.5. Quicker adoption of standards	1	8	<b>27</b>	21	4	7
B.3.6. Knowledge pooling and sharing	0	7	<b>34</b>	18	3	6
B.3.7. Better access to research results	1	13	<b>26</b>	20	2	6
B.3.8. Incentives for companies to share expertise	0	12	<b>28</b>	20	2	6
B.3.9. Better support of the Union policies	1	9	<b>27</b>	24	1	6
B.3.10. Facilitation of industrialization and deployment process	1	6	22	<b>30</b>	3	6
B.3.11. Research risk sharing and mitigation	3	6	<b>26</b>	<b>26</b>	1	6
B.3.12. Improved cooperation with 3 <sup>rd</sup> countries	2	12	<b>31</b>	13	4	6
B.3.13. Better market access	2	12	<b>31</b>	11	6	6

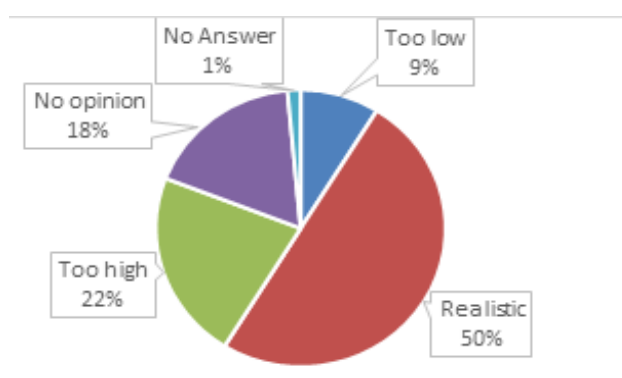
Responses to the open part of the question fell in to three broad categories:

- The creation of a common platform to share information and experiences, this was beyond just R&D and should be taken to include improved stakeholder interactions at an operational level (5 responses)
- The cross-border nature of the SJU creating inter-state synergies (3 responses)
- Creation of a strong link between the R&D and the wider SES policy in particular through the master plan (8 responses)

In addition, three responses indicated that the link to innovation (low TRL research) needed to be strengthened.

B.5. "Leverage effect" is defined as the ratio between the total contributions provided by the members of the JU other than the EU and the EU contribution. For the SJU there are no specific minimum expected leverage, but currently, for the activities foreseen under Horizon 2020, the ratio stands at 1.41 (825M EUR invested by Members against a 500M EUR EU contribution).

The current minimum leverage effect foreseen of 1.41 is. Is this realistic?



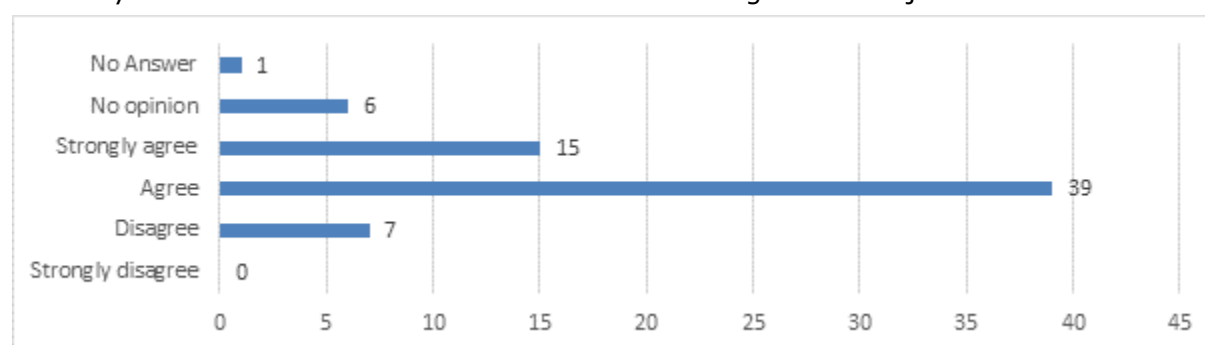
In the open part of the question sixteen answers included a proposed level:

Proposed Leverage	Rationale	Answers
2	To reduce member's dependency on EU funding	1
1.5 to 1.9	No rationale provided	2
1.41	Current level seems about right	3
1.4 to 1.3	As beneficiaries are large companies rather than SMES	3
1	Due to the high overheads of participation To correspond to NextGen where industry costs are covered in full	7

Answers that did not provide level tended to indicate that:

- Different levels are needed for different types of participation (e.g. higher for lower level TRL work)
- That overall level is too high (e.g. the level of co-financing from the Commission to too low).

B.6 Do you consider that SJU contributes to economic growth and job creation in the EU?



In open part of the question, the vast majority of written responses (29) felt that the link to deployment of new ATM systems in line with the SES policy goals creates jobs and economic growth. The McKinsey Macro-Economic Study was referenced as supporting evidence. Most written answers provide strong support for the policy link enjoyed by the SJU.

The other answers fell into three categories:

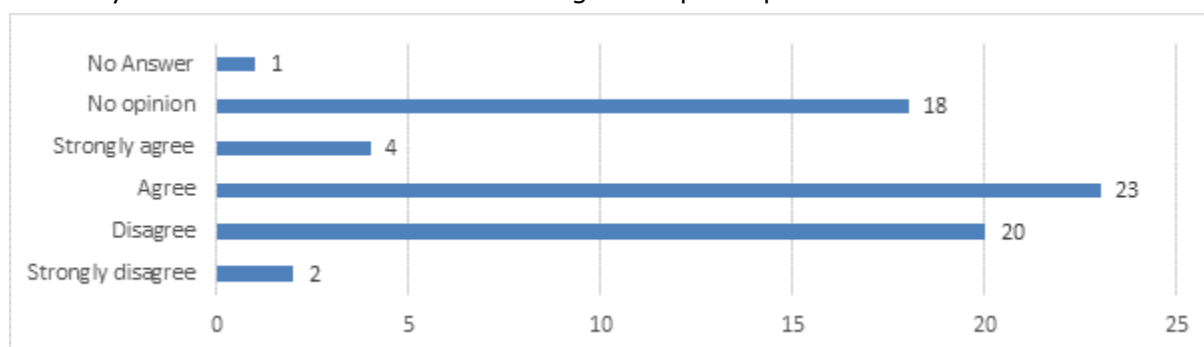
- Those who felt that R&D up to TRL6 itself does not create job (2 responses)
- Those who felt that SESAR created short term jobs for Members (4 responses)
- Those who felt that SESAR would in the end reduce jobs by creating a less labour intensive industry (2 responses)

#### 16.4. **Part C: Openness - Transparency**

C.1 Do you consider that the SJU website provides the general public and potential participants with easy access to information?

Value	Responses					
	Strongly disagree	Disagree	Agree	Strongly agree	No opinion	No answer
C.1.1. The SJU website provides easy and effective access to information to the public	4	8	<b>28</b>	24	2	2
C.1.2. The SJU website provides easily accessible and sufficient information about its funded projects	4	12	<b>31</b>	14	5	2
C.1.3. The SJU website provides effective access to information and sufficient guidance to interested organisations facilitating their participation in proposals	4	13	<b>29</b>	16	4	2
C.1.4. The SJU website provides easy and effective access to knowledge generated by the projects funded under this JU	6	16	<b>23</b>	11	9	3

C.2 Do you consider that the SJU encourages the participation of SMEs?

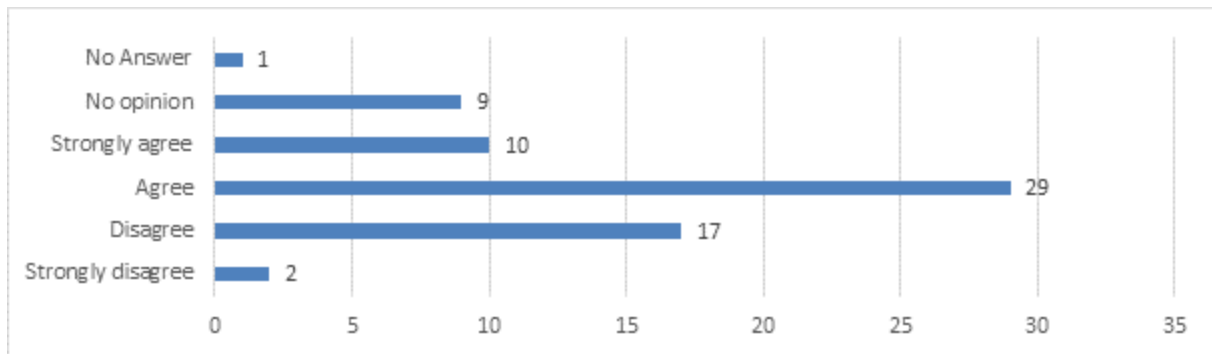


In written responses, it was noted that:

- SMEs tend to be involved through the supply chain of members, and that many had been involved via this route in SESAR1
- The direct involvement of SMEs is restricted to exploratory research.
- That there are no specific SJU initiatives to encourage SME participation
- The costs (particularly of Membership) and administrative burden are too high for SME direct involvement.



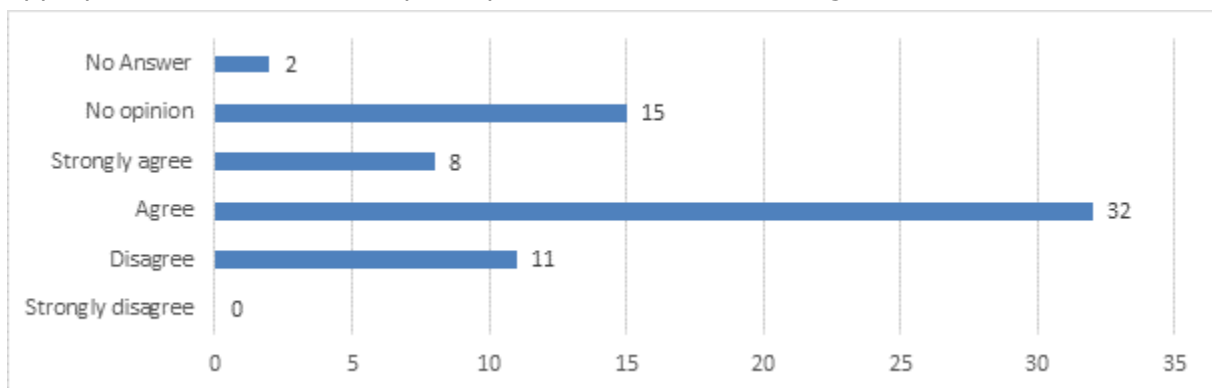
C.3 Do you consider that the current way of defining topics for the calls of proposals is open and inclusive?



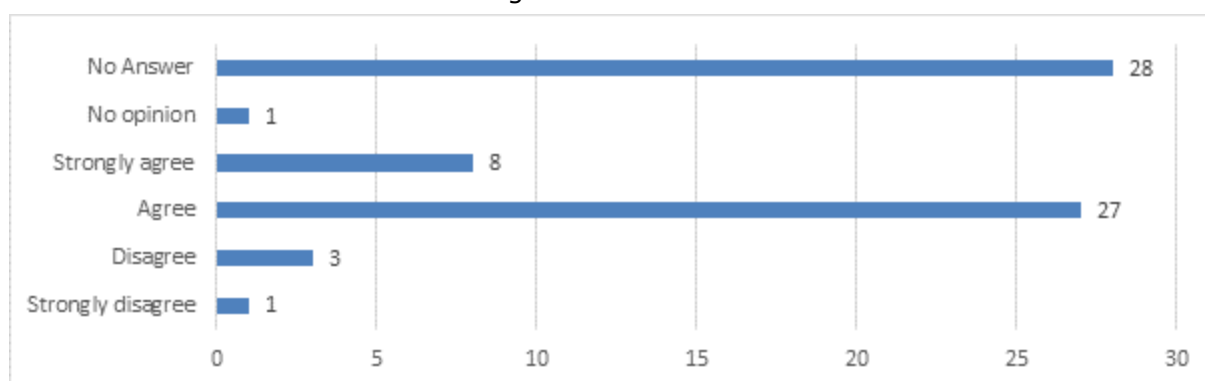
The written responses indicate that the topics covered by the SJU are identified within the European ATM Master Plan, which does have wide stakeholder involvement in the update process. However, it was also noted that:

- The process of defining the work programme for the Industrial Research is inclusive of the Membership but not the wider community. Most responses are supportive of this process.
- There is less dialogue concerning the nature of open calls (e.g. for the Exploratory Research) although others note involvement of ART and ASDA as sources of ideas. Most responses would support wider involvement still.

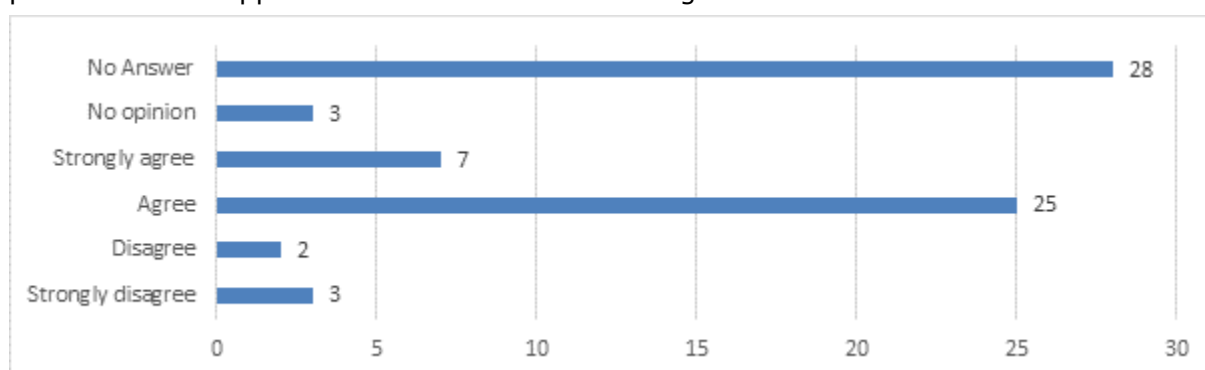
C.4. Do you consider that the budget split between members' activities (max. 70% of EU funding to the SJU) and non-members activities (min. 30% of EU funding to the SJU) is appropriate to ensure a wide participation of the sector at large?



C.5 Do you consider that SJU organises a sound and fair proposal evaluation system based on both scientific and technological excellence and industrial relevance?



C.5.1 Do you consider that the communication of the evaluation results and the feedback provided to the applicants is effective and meaningful?

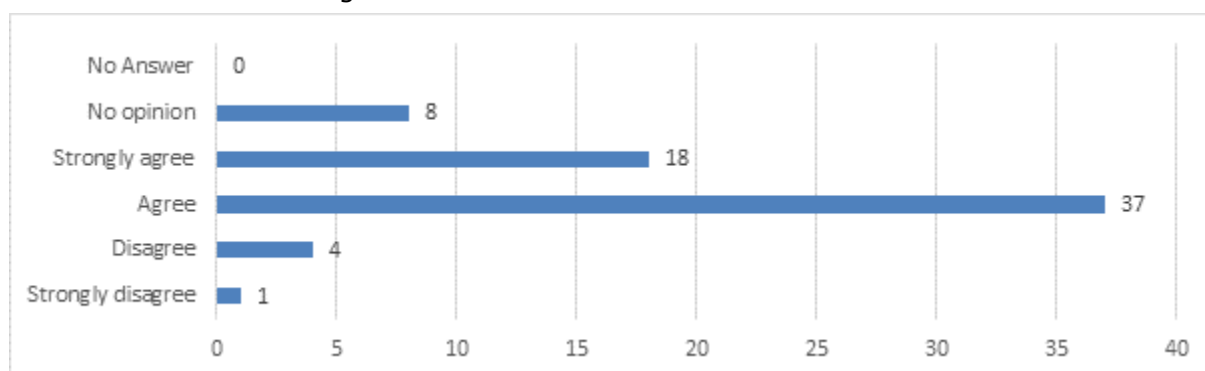


In the open part of the question the five respondents who disagreed with the feedback being effective and meaningful felt that the evaluation criteria were obscure and that more information could be provided. None are full members of the SJU. Full Members tended to have a more positive view of the evaluation process.

### **16.5. Part D: Relevance, Coherence and Effectiveness**

D.1. The research and development agenda of the SJU is set out in the European ATM Master Plan following a comprehensive planning exercise carried out in cooperation with the European Commission, Member States, various aviation stakeholders and SJU Members.

Do you think that this framework is the most appropriate for defining the European Research & Innovation agenda for ATM?



## D.2 In your view how effective has SJU been in terms of:

Value	Responses				
	Not at all effective	Somewhat effective	Very effective	No opinion	No answer
<b>D.2.1.</b> Supporting the development of ATM solutions	1	26	<b>34</b>	4	3
<b>D.2.2.</b> Accelerating ATM research	4	<b>32</b>	26	3	3
<b>D.2.3.</b> Validating SESAR solutions	4	20	<b>37</b>	3	4
<b>D.2.4.</b> Supporting the transition to standardisation and industrialisation	4	23	<b>25</b>	4	3
<b>D.2.5.</b> Resolving existing technical limitations (e.g. inter-operability problems)	6	<b>43</b>	12	4	3
<b>D.2.6.</b> Mitigating risks linked to innovation	3	<b>41</b>	16	4	3
<b>D.2.7.</b> Aligning ATM Research to the Single European Sky policy	2	21	<b>37</b>	5	3
<b>D.2.8.</b> Transitioning from FP7 to Horizon 2020 environment	8	<b>34</b>	16	7	3

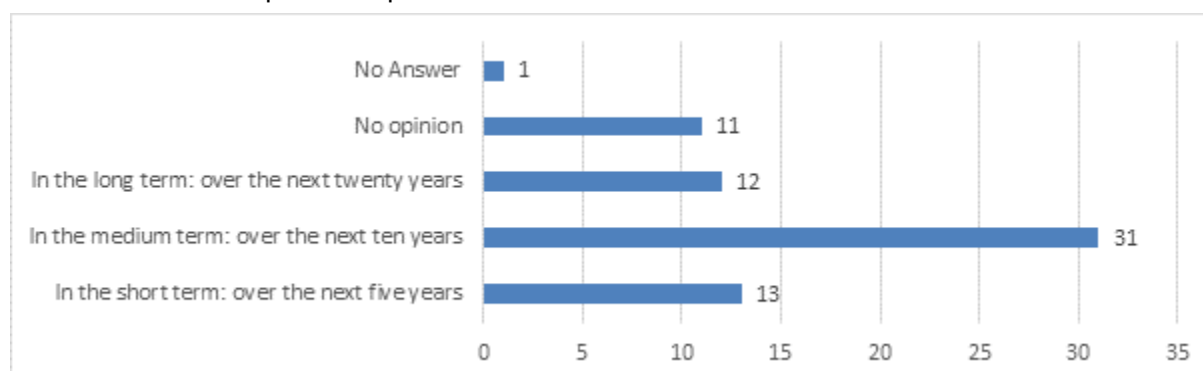
In the open part of the question 32% of the respondents felt that the SJU should undertake additional tasks. Of the 18 suggestions provided, eight related to the integration of Drones/UAS into civilian airspace. Four suggested broad “technology watch” task to ensure links to wider research and establish the future programme.

Four related to improved integration of the SJU in the wider policy area of the SES including providing improved linkage to deployment and standardisation.

It was also suggested that the SJU should have been more active role “during the “cooperative bid” / negotiation phase, to mitigate big industrial partners taking advantage of their position and often not getting the best technological solution for the European community as a result”.

The final suggestion was to strengthen the Scientific Committee.

## D.4 Do you think that the SJU can contribute towards improving the competitiveness and industrial leadership of Europe in the ATM sector?



Reasons provided for short-term leadership included:

- The SESAR Solutions Catalogue demonstrating real European knowledge
- The Pilot Common Project demonstrating the practicality of the solutions
- The role of SESAR in closing the gap between R&D and deployment
- Role of the SJU in promoting SESAR at ICAO, with the FAA and other regions

Reasons provided for short-term leadership included:

- A good balance between incremental technologies and more disruptive technologies
- The time required to industrialisation the outputs of the SJU
- The length of the innovation lifecycle
- The static nature of service provision within ATM
- Concerns over future deployment due to difficulties with VDL2 deployment

Reasons provided for long-term leadership included:

- The traditional slow timeframes for modernisation of ATM, particularly in terms of standardisation
- The need to educate other regions on the SESAR solutions
- The lack of pull-through from other industries (for example security)
- The need for wider commitment to the necessary change.

D.5. Which would you consider as major benefits of participating in a SESAR JU project?

Value	Responses					
	Strongly disagree	Disagree	Agree	Strongly agree	No opinion	No answer
D.5.1 Financial support for innovative research and development	1	4	21	<b>40</b>	2	0
D.5.2 Greater visibility across Europe/Reputation	2	1	28	<b>35</b>	2	0
D.5.3 Enhanced access to new markets, business opportunities and funding sources	1	12	<b>25</b>	19	1 1	0
D.5.4 Inclusion in open innovation networks, with direct contact to leading researchers in universities and the industry	1	7	<b>27</b>	26	7	0

In the open question the following additional benefits were mentioned:

- Collaborative environment supporting cross border understanding and cooperation (12 responses)
- Fostering of innovation (2 responses)
- Reduction in time to market for new products (1 response)

It is important to note that the benefits of collaboration are to the wider ATM industry and not just to R&D.

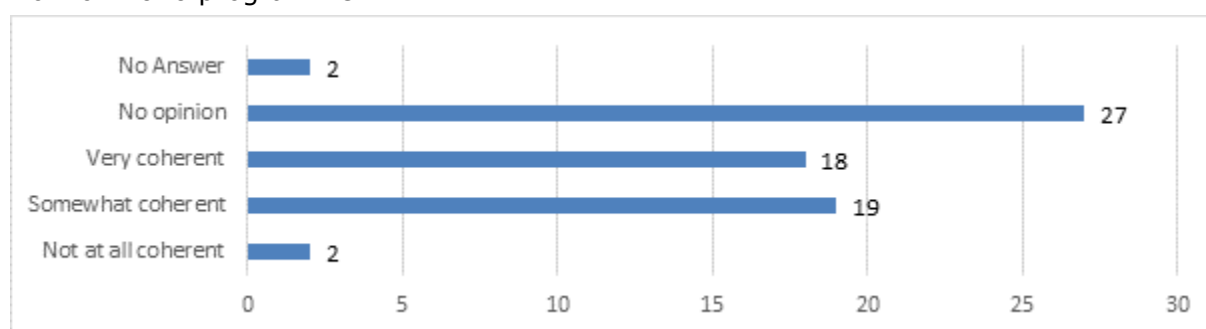
D.7 Do you consider that SJU projects have resulted in specific scientific and/or technological successes?

75% of respondents felt the SJU projects had resulted in scientific and/or technological success. The areas mentioned most frequently were:

- Time Based Separation
- Airport Collaborative Decision Making and Airport Integration with the Network
- Remote Towers
- Extended Arrival Management
- SWIM
- Satellite Communications
- i4D

In addition, it was noted that the SJUs support of VDL2 response was a positive role with an important technological enhancement.

D.8 To what extent are the activities of the SJU coherent with other activities of the Horizon 2020 programme?



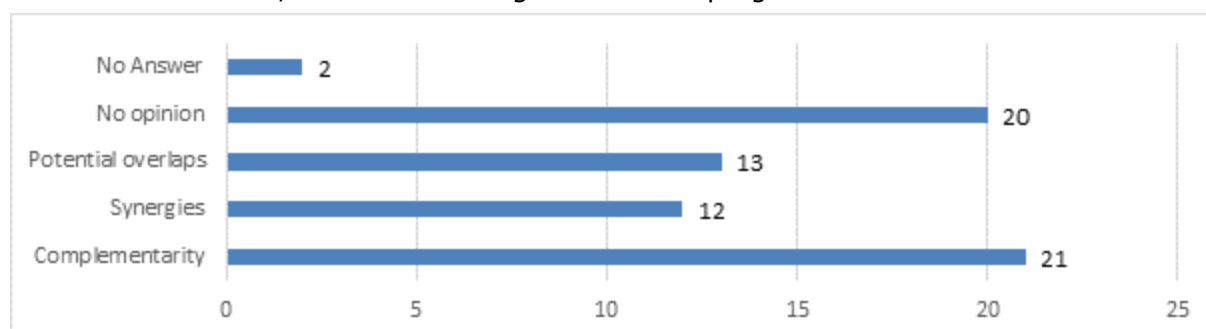
From the open part of the question it is clear that there was insufficient knowledge from most respondents on the wider Horizon 2020 programme to answer the question.

The two responses stating that SJU activities are not coherent with the Horizon 2020 programme are critical of their inclusion in Horizon2020

The rationale for "somewhat coherent" was that more could be done to build synergies with the other transport JUs (in particular Clean Sky) and other areas such as cyber security, robotics and machine learning.

The rationale for "very coherent" was either that SJU is coherent because it follows the H2020 rules or because of existing links with Clean Sky. A number of respondents also pointed out that both SESAR and H2020 are consistent with the EU Transport Policy and are therefore coherent.

D.9. What is the relation of the SJU with other Union funding programmes and/or with similar international, national or intergovernmental programmes?

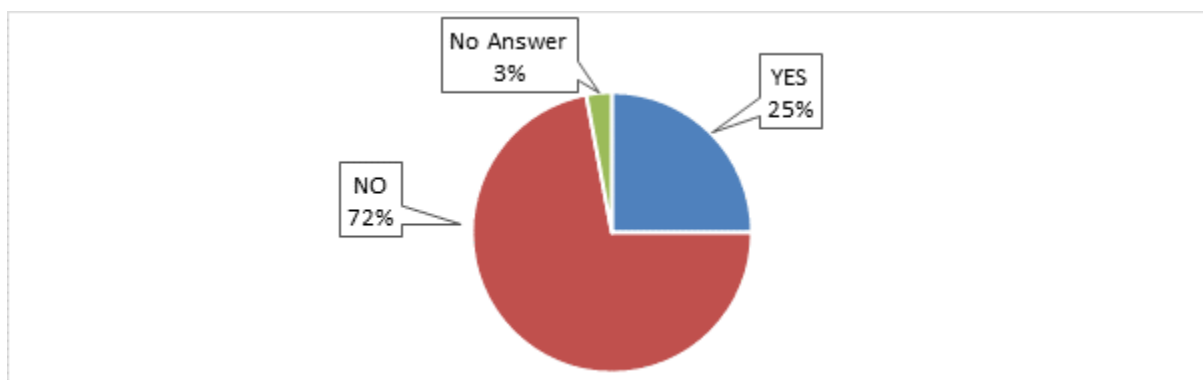


The following table summarises the justifications provided.

Answer	Justification
Potential Overlaps	The projects GAMMA, SANDRA and ARIEL are listed as potential overlaps Both Clean Sky and SJU have worked on helicopter flight procedures.
Synergies	Links to Clean Sky Links to the German National Programme (where some funding is made available for topics not considered within SESAR, with some evidence of cross fertilisation)
Complementarity	The strong link between SJU activities and those of the SESAR Deployment Manager funded through the Connecting Europe Facility The links between SJU and other EU bodies such as EASA and EDA The links between SJU and international bodies such as FAA (NextGen) and Japan (CARATS)

Respondents also noted that as a stated role of the SJU is to coordinate all ATM R&D that there is no other European funding available to support ATM Research outside SESAR.

D.10. Do you have any experience in combining different sources of EU funds and/or with national funds for research and over the innovation value chain?

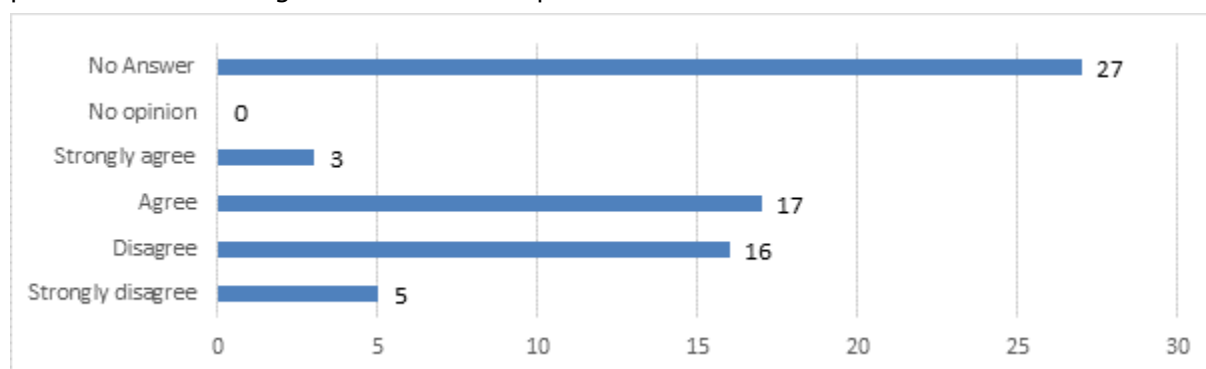


Most of the open text answers indicated the difficulty in achieving complementary financing from multiple sources. There were two positive responses:

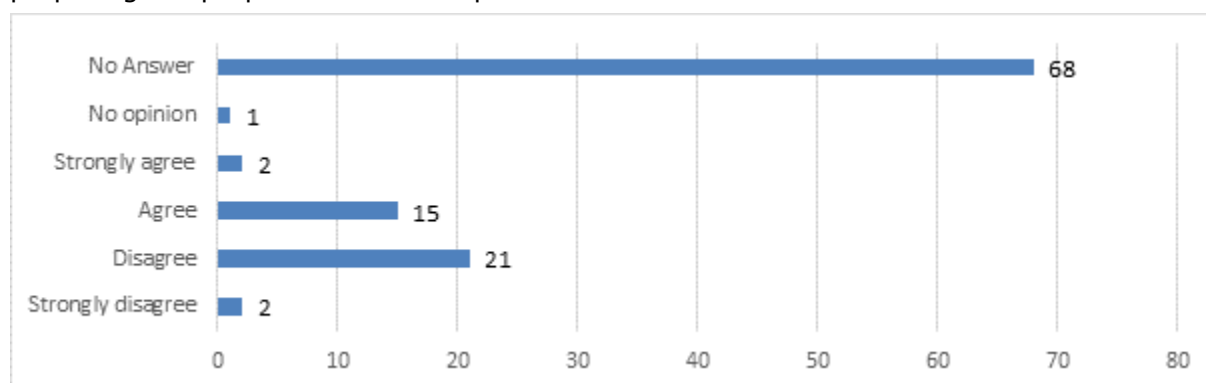
- Due to the complementarity over similar topics, similar research topics can be efficiently developed by using at the same time funding from CS2, SESAR and national funds.
- COST framework is a generally good idea - to bring together and to an extent facilitate joint work of researchers from different countries addressing similar research topics (often with national research grants). Establishing networks (or centres) of excellence within several research fields also seems like a possibly fruitful framework.

## 16.6. Part E: Efficiency

E.1 When you applied for funding from the SJU, did you think that the application procedure was straightforward and simple?



E.2 When you applied for funding from the SJU, was the administrative burden for preparing the proposal within acceptable limits?



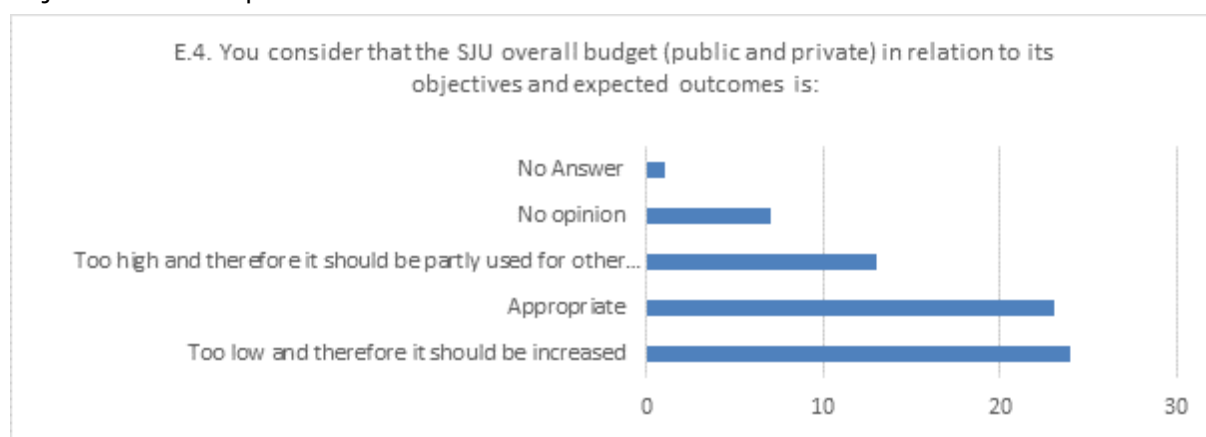
E.3 Can you make any suggestions for improvements or simplifications to the application procedure?

Twenty-six percent of respondents felt that improvements were possible. The following suggestions for were provided:

- Remove the additional complexity introduced by the Horizon 2020 rules over those used for SESAR1.
- Reduce the complexity of the required proposals
- Reduce the complexity of the funding rules
- Provide alternative approaches to Membership (as was the case under SESAR1)
- Remove the duplication between the grant award process and the application process.
- Adapt the participant portal to support consortia operating within a project. The tool is not adapted to the need of the SJU or its members.

Nearly all respondents providing a comment expressed concern over the application of Horizon 2020 rules which were seen as costly and time consuming.

E.4. You consider that the SJU overall budget (public and private) in relation to its objectives and expected outcomes is:



The following table summarises the rationale provided.

Answer	Justification
Too High	<ul style="list-style-type: none"> <li>Funding programmes looking at lower TRL Levels like the Exploratory Research part of the SJU as well as the conventional funding of ATM related Topics as part of the Horizon 2020 Programme should be increased. Otherwise there is a big danger that Europe does not generate enough new ideas related to ATM for the future beyond current SESAR (x3)</li> <li>Results are not sufficient to justify increased budget.</li> </ul>
Appropriate	<ul style="list-style-type: none"> <li>The main issue in European ATM modernization is deployment and overcoming national barriers, monopolistic interests and non-willingness of change resistant ATM actors</li> <li>Funding for Exploratory Research is not sufficient and quite often attacked by subjects which not really innovative such as RPAS</li> <li>The SJU overall budget is appropriate. It seems, however, that there is too much funding for parallel developments, thus fragmenting the efforts (and probably the results), and not enough funding for truly innovative research.</li> </ul>
Too Low	<ul style="list-style-type: none"> <li>A higher budget is required due to the complexity and difficulty of the overall task of modernising European ATM</li> <li>Reduction of public budget between SESAR1 and SESAR2020 has resulted in lower Member contributions and a prioritisation of work which means some Members are not contributing in all areas they wished to.</li> <li>Greater funds are required for the Exploratory Research.</li> </ul>

The answers do follow pattern of Member wanting more money for Industrial Research and non-Members want more money for Exploratory Research.



## 16.7. **Part F: Overall**

Respondents were asked to provide any final comments. The following unique responses were provided.

This partnership is the example of a good cooperation between Brussels and the aviation community in the service of air passengers.
Efficiency in large programmes sometimes quite low; some Partners only look for funding and do provide only Minimum contributions; EU oversight could be stricter in such cases. number of Partners should be restricted because otherwise Management Overhead can be quite heavy.
The management costs of EU funded projects from preparation to dissemination are still very high as compared to US. Deliverables are considered the financial spreadsheets instead of the results by themselves.
To continue successfully supporting industry in establishing the Single European Sky, the SESAR JU should fully embrace the challenge of Drones insertion in the airspace, both in terms of airspace insertion for certified and specific drones, and in terms of UTM (Unmanned traffic management). Given the challenges ahead and the evolution of technologies, the SJU should undertake the preparation of SESAR 3 without waiting for the end of SESAR 2020.
SJU has been and is still a strong tool to bring together all key actors from R&D to manufacturing industry in a coherent programme strengthening quality of validation and shortening path to deployment
H2020 funding are great to support short-term improvements and in the case of SESAR SJU to support the implementation of a regulation. But, we cannot consider that this objective will sustain jobs and maintain the place of the European industry in front of giant like Google, Microsoft and even Facebook which already started to develop ATM solutions. It maintains jobs for the short term but what next?
The SJU provides a vital role in bringing together the key stakeholders to work collaboratively to deliver the SESAR Solutions in support of the ATM Master Plan and SES.
International collaboration with the USA (NextGen), Japan (CARATS) or other countries like Australia should be supported in a similar way that H2020 can support collaborative projects with non-EU members or associated countries.
JTI are important catalysts for industry participation and industry interests in Horizon 2020. The JTIs have become important parts of the European innovation system. It is important to ensure that all calls through JTIs involving Horizon 2020 funding are open for all potential participants, and to avoid tendencies of "closed clubs". JTIs should be open and transparent from their inception, not only when they are formally constituted. It's important to keep a balance between the amount of funding channelled through these initiatives and traditional calls.
SESAR, as a JTI under H2020, should also comply with the same level of transparency (e.g., financial reporting in the eCORDA database with the same level of detail as other H2020 programmes).
Ensuring larger diffusion of SJU publications addressing work achieved and results obtained could be an incentive for members at contributing more to the undertaking. In general, access to and sharing of knowledge outside SJU members is deficient. This is an additional hurdle for external participants in open calls. SESAR provides a sort of "label", i.e. an informal recognition, that is useful to members. Most of SJU calls are limited to members, which is a useless and even critical in novel technological areas. Technology evaluator of Clean Sky could be used transversally by SJUs.



## 17. ANNEX G: RESULTS OF THE PROJECT COORDINATORS SURVEY

### 17.1. Context

The Beneficiary Survey was distributed to 179 organisations on 2<sup>nd</sup> February 2017 with a response date of 24<sup>th</sup> February 2017. There were 49 replies.

The questions cover the seven areas:

- Part A: Role within SESAR (4 part questions)
- Part B: The application process (16 part questions, 2 open)
- Part C: Grant finalisation phase (8 part questions, 2 open)
- Part D: Communications and Interactions with SJU (27 part questions, 2 open)
- Part E: Overall performance of the SJU (4 part questions, 2 open)
- Part F: Project Objective and Impact (10 part questions, 2 open)
- Part G: Content of the overall programme (4 part questions 1 open)

The survey was anonymous, the experts evaluating the answers are not aware of who provided each answer. This leads to difficulty in assigning views to particular stakeholder groups (e.g. research community, Manufacturer, service provider, service user – e.g. airline). From the questions/answers provided it has not been possible to determine fully if the respondent was a Member of the SJU or a participant in an open call. This reduces the usefulness of the survey results.

Further although the survey introduction requested feedback on the entire lifecycle of SESAR, in general the questions are not specific to SESAR1 or SESAR2020. In most cases when analysing the answers it is not possible to draw a distinction between the phases of the SESAR. In most cases, it is assumed that answers refer to the recent calls under SESAR2020 and Horizon 2020 rules. Limited value can therefore be attached to the survey results for the final evaluation of SESAR1.

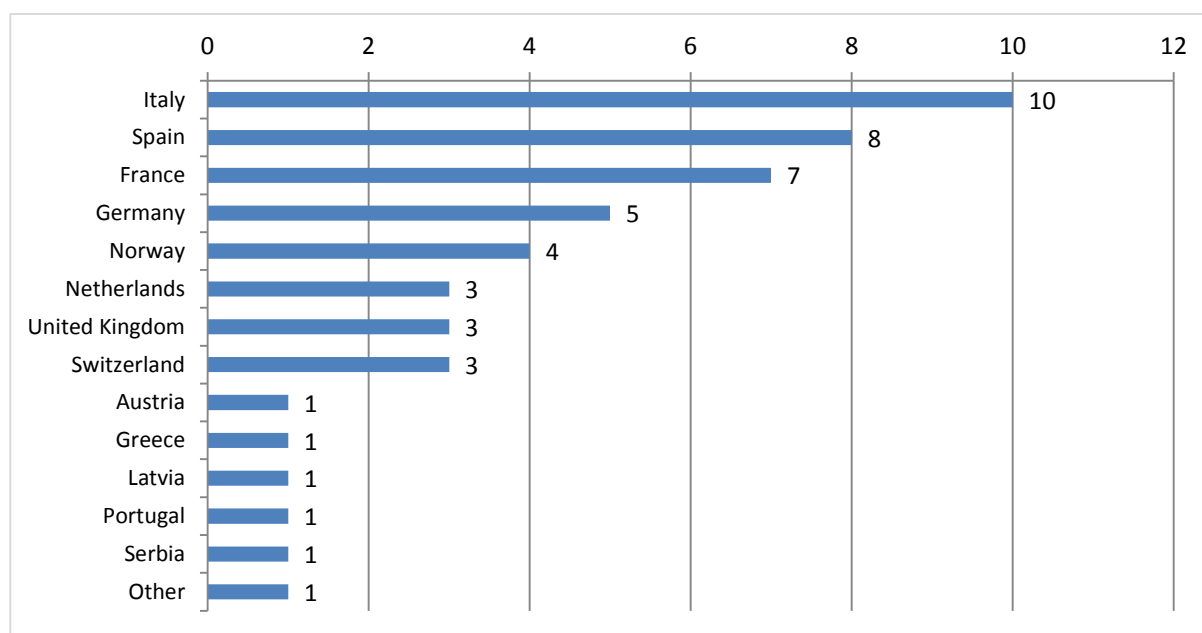
The following sections provide a summary of the answers provided. Answers to open questions are provided “as-is” except for corrections to spelling and removal of information that could identify the respondent.

### 17.2. Part A: Information About You

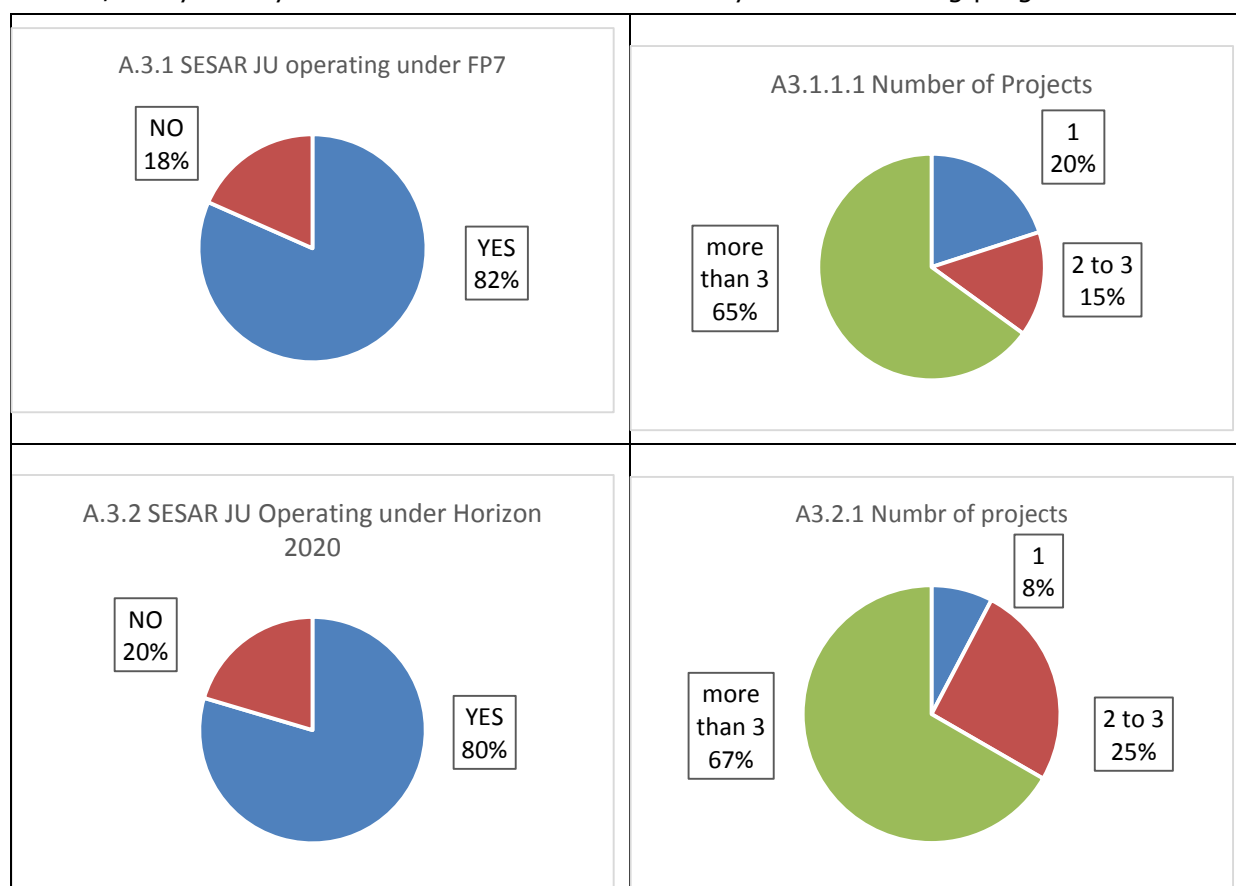
A.1 The organisation to which your research team belongs is a...

	Count	%
Academia (University or higher education institution)	7	14.3
Public or government sector, e.g. research performing organisation	10	20.4
Private, not-for-profit sector, e.g. research foundation	6	12.2
Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding	16	32.6
Private industry contributing/having contributed in-kind to SESAR project(s)	9	18.4
Other	1	2.0
Total	49	

## A.2 Please enter your current country where your research team is based

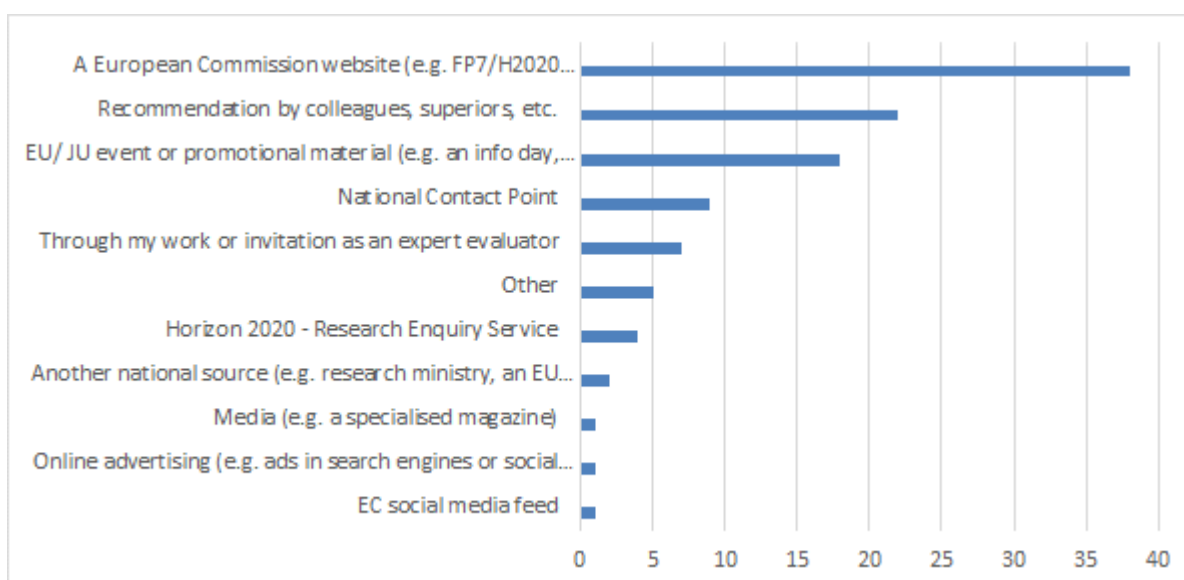


## A.3 Is/was you or your research team involved in any of the following programmes?



NOTE: 33 respondents worked in SESAR1 and SESAR2020; 3 worked in neither.

## A.4 What are your main channels of information on SESAR JU opportunities?



### 17.3. Part B: Application process

	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
B.1.1. Information for applicants was easy to find (e.g. about the call objectives, eligibility and selection criteria, documentation needed, etc.)	20	19	7	1
B.1.2. Information for applicants was clear (e.g. about the call objectives, eligibility and selection criteria, documentation needed, etc.)	19	19	6	4
B.1.3. I knew who to contact for any question(s) I had or where to get help when preparing my application	16	22	7	2
B.1.4. I knew who to contact for any question(s) I had or where to get help when submitting my application	20	16	8	2
B.1.5. The requirements for application process were reasonable and proportionate (e.g. the volume of proposal, requirements for supporting documents, etc.)	15	19	11	3
B.1.6. The evaluation process was clear and transparent	16	23	4	5
B.1.7. The electronic tool used for submitting the application was user-friendly	11	18	11	3

B.1 Please assess the following practical aspects of application process:

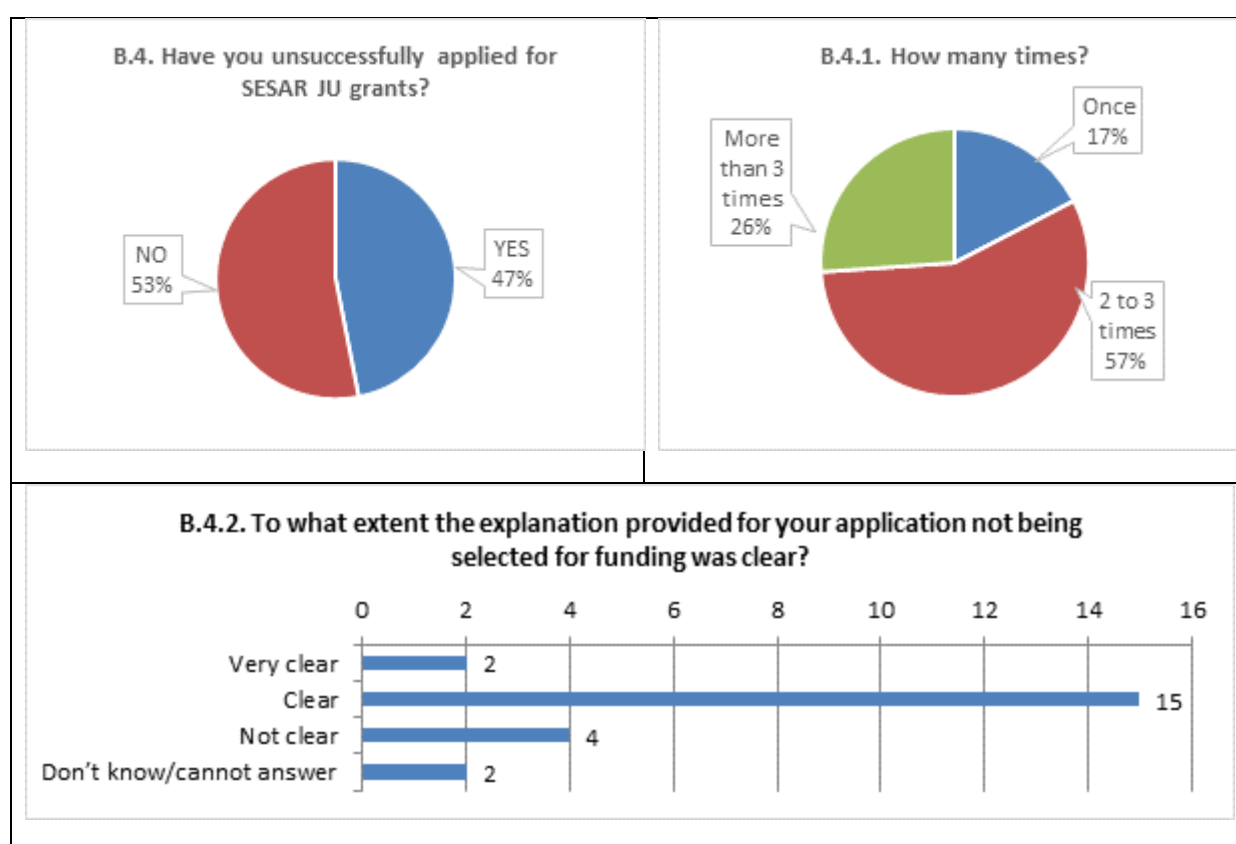
B.2 Open Question: Practical aspects of application process not mentioned above.

<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
The formal answering during the bidding process was sometimes lengthy. However, it seems (more) difficult for a longer research programme in the framework of H2020 than under FP7. Nevertheless, the information exchange was as transparent as possible and better than for other calls (e.g. CEF).
More stability of tools is required and should only aim at diminishing 'bureaucracy'!
Due to complexity of ATM, Industrial Research requires continuity over period of time (going form

V1,V2, V3, ...) and actors based on heavy and trusted coordination. Indicator/criteria for the convergence of actors should be considered as key while not impairing innovative thinking and introduction of newcomers/new actors.
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
Some difficulty was experienced in fully understanding the registration and application requirements but familiarisation has helped overcome minor issues.
The main difficulty in the SESAR 2020 process was the EC decision to combine the SES Regulation with the H2020 regulation, partly contradicting with each other. H2020 puts additional administrative burden on the SJU members, resulting in less available budget for industrial work. H2020 did not consider the specialities of the SJU setup with consortia being SJU members by its own. The solution how a member being a consortia can be part of a specific action together with other members has only be found in the last minute and created a high level of uncertainty and high effort on SJU member side
More information about the selection process would be very helpful: is the JU contributing to it and with which role? are the reviewers informed or aware of the JU priorities? Information about the reviewers would also be useful: how many are them? level of experience? experience field? etc. All these factors affect the evaluation of the proposal and should be considered when preparing it.
Most appreciated was the "light" submission process for SESAR1 IFTDA or LSDA projects. The administrative burden required by H2020 rules is unfortunately drastically increased...
We had a Consortium of 15 Members exceeding the 375k€ threshold requiring an audit. Some Members however had a strategic role but with limited contribution (less than 30k€). For those Members, the audit process/cost was disproportionate in respect to the contribution.
I found the call text for exploratory research projects confusing. The projects should be exploratory, low TRLs, but the call text was very technology oriented, providing some examples, which could be taken as defining the scope, or just as examples.
<b>Private, not-for-profit sector, e.g. research foundation</b>
When I submitted my proposal approx. ten minutes before the deadline, a revised version of Part A was successfully uploaded. However, the "submit" button did not respond after several minutes, meaning that the revised version of Part A (although uploaded) was not included in the submitted proposal.
The volume of the proposals is absurd; a lot of the information that must be included are useless and are not related to the scientific excellence. For instance, at the end you have to include 10 pages about the management of the consortium; which has nothing to do with the wiliness of the partners to work together. The evaluation process is far from transparent. It is not strange to get conflicting comments; and in general a project is rejected or accepted (thus M of € are distributed) based on 5 lines of comments.
The process for SESAR1 (FP7) was run by SJU and this was also the expectations for SESAR 2020. This changed along the road and created a lot of uncertainty before it was finally clear that H2020 rules were to be followed almost completely. The period before the Call was announced was too long (preparation phase). A lot of problems aligning the JU membership and the H2020 beneficiaries (i.e. who should be allowed to apply to the closed Call)
In H2020 it was not clear what was the difference with the earlier process under FP7.
bugs in the tool which caused some delay for the finalisation of applications
H2020 rules not flexible enough
In few cases, answers to specific questions are difficult to find. Furthermore, some improvements to the on-line manual could be introduced, collecting most relevant doubts from the FAQs.
<b>Academia (University or higher education institution)</b>
as university (public body) some administrative required documents were difficult to obtain

B.3 How would you assess the overall timeliness of the following processes during the application stage?

	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
B.3.1. The time period from the call deadline to the time the outcome of the proposal was announced to you (i.e. time-to-inform)	5	26	13	2
B.3.2. The time period from the announcement of your proposal's outcome to the time you signed the grant agreement (i.e. time-to-contract)	2	28	11	5
B.3.3. The overall time period from submission of the proposal to signature of the grant agreement (i.e. time-to-grant)	2	23	14	5



B.5 Open Question: Comments regarding the application phase of SESAR JU grants

**Private industry contributing/having contributed in-kind to SESAR project(s)**

The implication of the H2020 framework on the set-up of the PPP was well underestimated (probably from all involved parties). It's less of an SJU issue but rather the quite strict H2020 rules which cause a lot of administrative burden without any content work (e.g. all consortium members need to be beneficiaries even if only one of them participates in a project).

Whereas independent expert used in the process is not questioned, independent experts in the area of 'industrial research' in ATM encompassing knowledge of both air and ground industry should not be selected from university/research centres experts network. Role of JUs should be broaden in this matter with adequate control mechanism.

**Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding**

A better guidance through the process in such a complex environment with 2 partly contradicting

regulations would be helpful, Better alignment between the different departments within EC is essential for efficient proposal preparation
The SESAR2020 rules have resulted in a significantly increased complexity over SESAR1 in the preparation of grants.
In the last call (the one published on 15 December 2016) there is no information about the expected size of the projects. This is a useful input that is normally available for other H2020 calls.
A clear shorter sum-up document would be very useful, allowing to perform more efficient application of grants.
<b>Private, not-for-profit sector, e.g. research foundation</b>
Following the technical problem mentioned above (submit button failed), I immediately lodged a complaint. I received a formal acknowledgement with a statement that I would receive a formal answer to the complaint within one month. Despite sending numerous reminders, no response was ever received (other than email saying "you will receive a response in due course"). I continued to complain right up to the stage where the grant agreement was signed, but NEVER received a reply.
The applicants put a lot of effort into the preparatory work (e.g. preparing Description of Work, took part in negotiations, etc.) which took years and was not funded.
<b>Public or government sector, e.g. research performing organisation</b>
Success chances by about 5-10% are much too low. Application effort is very high compared to the success rate.
Rejection of a full project and lack of negotiation is inappropriate (e.g. Drone activity in PJ13)
Few doubts experienced in managing the need for Consortia partners to have an Audit Certificate on the final cost statement.

#### **17.4. Part C: Grant finalisation phase**

C.1. To what extent do you agree with the following statements about the practicalities of the process of finalising the grant?

	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
C.1.1. The JU staff assigned to my project in the grant preparation phase were easy to contact and responsive	25	11	5	1
C.1.2. Requests from the JU were clear (e.g. for proposal modification, providing missing information, etc.)	15	20	9	0
C.1.3. The electronic tools used in the contracting process were user-friendly	8	20	12	4
C.1.4. The electronic tools used for the validation of beneficiaries were user-friendly	10	14	9	3
C.1.5. The process of validating the beneficiaries was smooth and required reasonable effort	11	10	11	4



## C.2. Open Question: Practical aspects of grant finalisation phase not mentioned above

<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
Feedback during time dedicated to the validation of beneficiaries would have been highly appreciated from the reception of documents until outcome (positive or negative). No information is provided, no delay until the assessment, no communication possible. You might even not know whether the documents have been received.
<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
It links to comment in B.5.1: administrative effort seems sometimes not appropriate when not contributing but still "beneficiary" with 0 effort/grant.
Seems that focus was given too much on formalities during the evaluation process, and not the content of the proposals. This resulted in useless effort for adapting text, paragraphs although from content perspective everything was clear (e.g. a point was missing somewhere and has been requested to be changed)
A very significant amount of time has been lost in finding workaround to many IT issues (e.g. re-collection of lost information, denied validation due to minor typos, case sensitive fields, etc...). Still much room for improvement!
We had to send twice our documents to the EU, as our first ones were lost. Very complicated process with LEAR and Signatory
Ethics deliverables were added, with too short descriptions to understand what they were about and a non-realistic timeline of submission, not linked with the project overall timeline.
<b>Private, not-for-profit sector, e.g. research foundation</b>
The information requested about justification of "other direct costs" made no sense. Detailed information was already provided in the proposal justifying costs for ALL partners (even those with less than 15% of personnel costs), but we were asked to provide specific details for those over 15%. This led to meaningless repetition of information that was already present, and seemed very much like a bureaucratic process gone completely mad, providing no useful information.
It was very unclear all procedures related to consortia which were JU Members, since each partner of the consortium was not allowed to apply to any Project (until this was changed/corrected)
<b>Public or government sector, e.g. research performing organisation</b>
Electronic signatures by CEOs via a portal is not easy.

## C.4. Open Question: comments and suggestions on simplification and service improvement

<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
The SJU staff involved in the process were helpful and communicative.
additional effort for ethics requirement, additional review time slot and huge general effort to manage especially small funding Projects is not known and planned when submitting the proposal.
This would be worth investing in a more User-friendly interface !
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
Ethics requirements and understanding was really poor.
The issue with the 50M€ funding of SJU seems artificial and created a lot of extra work. Could have been handled more effective
The tools should be ready (debugged) before applying the process and more stable over time.
<b>Public or government sector, e.g. research performing organisation</b>
Prohibit use of email with no reply address, message exchange through the portal is too heavy (connection, navigation, etc.)

## 17.5. **Part D: Communication and interaction with you**

D.1 How useful were the following methods of communication used by the SESAR?

Method	Very useful	Slightly useful	Not useful
D.1.1. E-mail contact	34	11	2
D.1.2. Telephone contact	22	10	4
D.1.3. Face-to-face contact (meetings, events)	26	10	4
D.1.4. Recorded messages (e.g. video briefings)	1	5	3
D.1.5. Live web briefings (with a chat function)	8	9	4
D.1.6. Information available on JU's website	9	23	6

D.1.7. Open Question: Please describe for which purposes you used these communication channels

<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
These channels of communications are being used as part of the on-going study projects execution as well as to be informed of the developments and related opportunities for contribution in the future
Clarification purpose, checking assumptions, advice. Communication channel with SJU is prompt and reactive.
To clarify administrative and technical details during the contract execution
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
High level contact to the SJU' per telephone for clarifying important strategic question where typically the PJ officers had no insight into transversal topics across all PJs
Doubts in the preparation of the proposal
Management of SESAR projects, preparation of new grants, ...
We mainly used e-mail and telephone contact for communicating with our SJU project officer, communication has always been fluent and all the officers have been very responsive.
Gate review preparation and use of the SJU extranet for sharing documents with the project
Many contacts happened via ECAS, but the messaging system is clumsy, so many threads moved to move to email to be more efficient.
These were the communication channels during 5 years working with the SJU.
<b>Private, not-for-profit sector, e.g. research foundation</b>
Discussions about details needing clarification for finalisation of the grant.
To find out the requirements for the application and partners
<b>Public or government sector, e.g. research performing organisation</b>
Resolution of various issues and bugs of the portal
Direct phone call and Face-to-face meetings have been used for planned Gate meetings, and to manage needs for changes to grant (i.e., extension of the project).
The SESAR JU has demonstrated to be very willing to assist, however using only a limited amount of channels. Any questions about opportunities would be directed towards the Q&A-email address. This meant that face-to-face meetings and questions through telephone were not answered. The challenge with the Q&A is that it takes a while for answers to be provided, delaying the proposal process significantly.

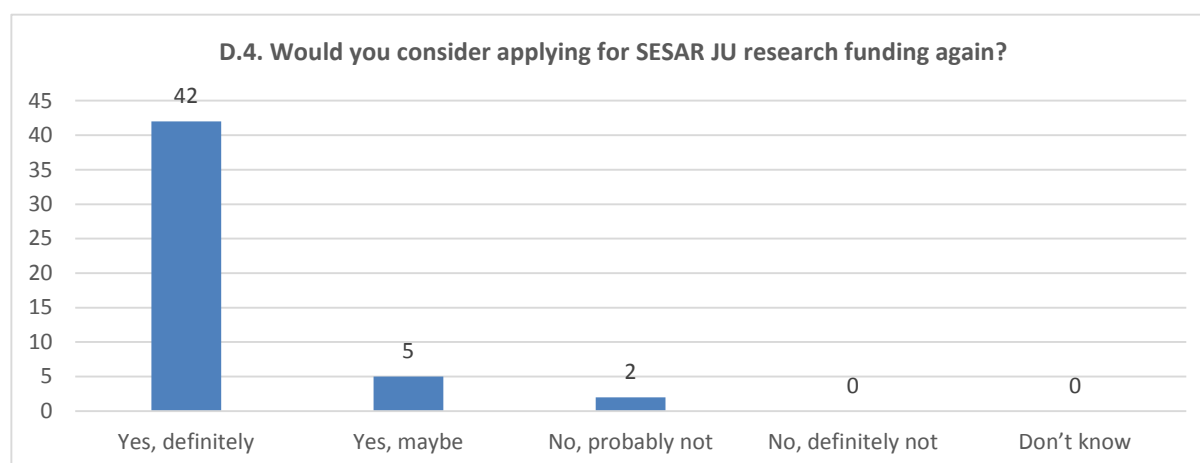
D.2. How important do you think the following factors are when you deal with the JU?

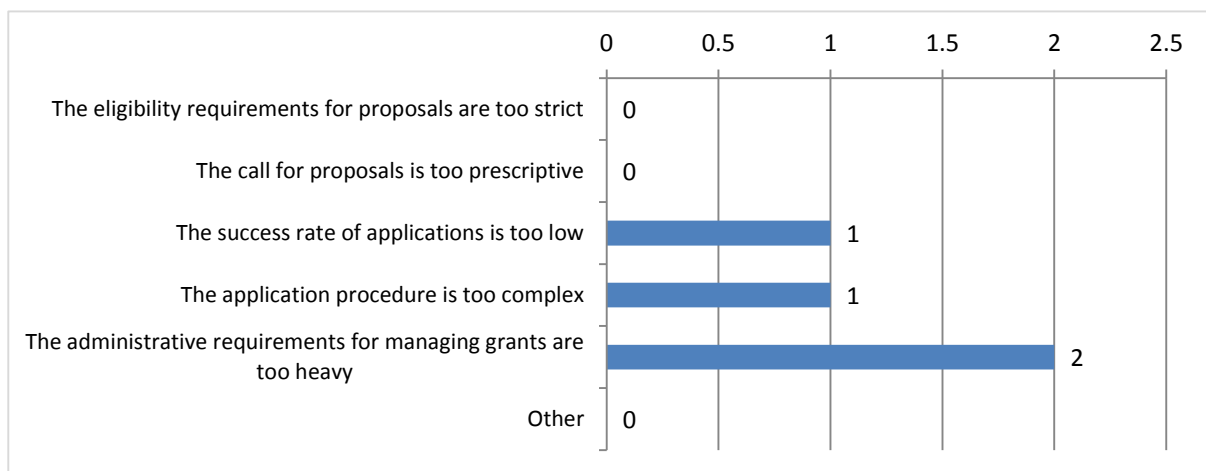
Factor	Very important	Slightly important	Slightly unimportant	Very unimportant
D.2.1. Clarity about the JU's procedures	29	13	2	2
D.2.2. The JU's website and communication materials	18	20	5	3
D.2.3. Accessibility and clarity of information provided by the JU	25	19	2	0
D.2.4. The JU's ability to perform the service promptly, accurately and transparently	27	17	1	1
D.2.5. The JU's willingness to help you and provide personal attention	27	13	1	4
D.2.6. The knowledge the SJU employees possess	29	11	4	2
D.2.7. The willingness to help, courtesy and cooperation of the JU's employees	31	13	1	0

D.3. Based on your experience, how much do you dis/agree with the following statements about the performance of the JU's actual services it provides?

Factor	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
D.3.1. The JU's website and information materials are visually appealing and user-friendly	17	21	6	0
D.3.2. Information provided by the JU is easily accessible	9	25	9	0
D.3.3. The JU methods of communication provide relevant and useful information	12	27	5	0
D.3.4. Events organised by the JU are useful (information days, project meetings, information visits, etc.)	20	17	4	1
D.3.5. The JU strives to provide excellent programme management and high quality service	23	17	4	2
D.3.6. The JU's procedures are transparent	20	16	7	3
D.3.7. The JU's documents do not contain mistakes or errors	15	20	5	2
D.3.8. The JU's employees are committed to doing quality work and provide a prompt service	28	14	1	0
D.3.9. Employees in the JU are knowledgeable and competent	26	14	2	2
D.3.10. Employees in the JU are consistently courteous and always willing to help	28	15	1	0
D.3.11. Employees in the JU are cooperative and give personal attention	29	12	2	0
D.3.12. When you have a problem, the JU shows a sincere interest in solving it	25	17	1	0

#### SESAR JU research funding applications





D.5. Which are the main reasons for your answer?

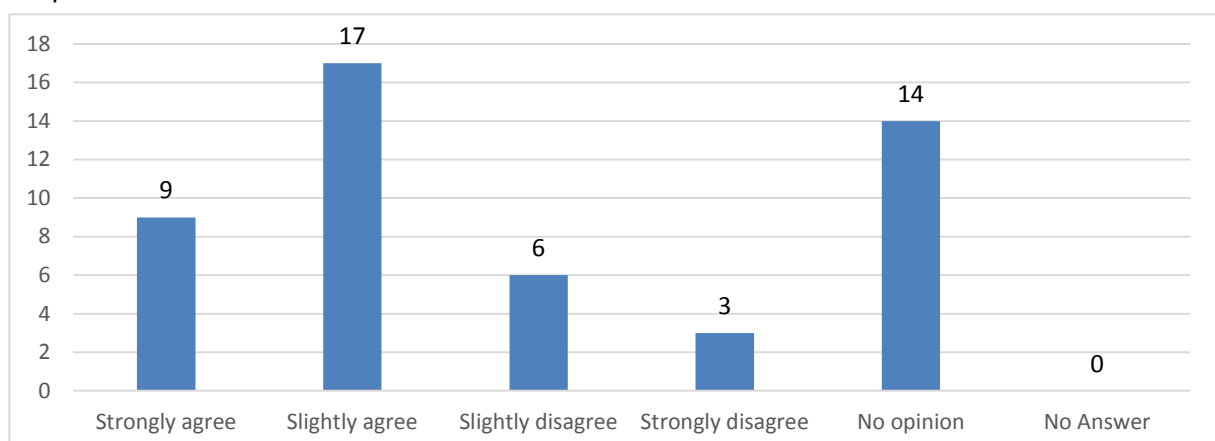
Rationale provided by the two respondents that would probably not re-apply:

I am responsible for a small, simple project with a limited budget. However, my impression is that SJU procedures apply the same techniques as would be relevant for a very much larger and more complex. The level of detail of planning is out of proportion with the project. The frequency of financial reporting (every 6 months) is excessive. Feedback on deliverables has had a very strong focus on bureaucratic details, and very little on actual content. Criteria for assessment of deliverables was made available only after submission, rather than before. The whole experience is demotivating.

Processes are too much top down. 1000 different Guidelines and Project Management rules make projects too bureaucratic Projects instead of Research Projects. Politics rules over content

## 17.6. Part E: Overall performance of JU

E.1. In general, the second generation of the JU presents an improvement compared to its predecessor under FP7

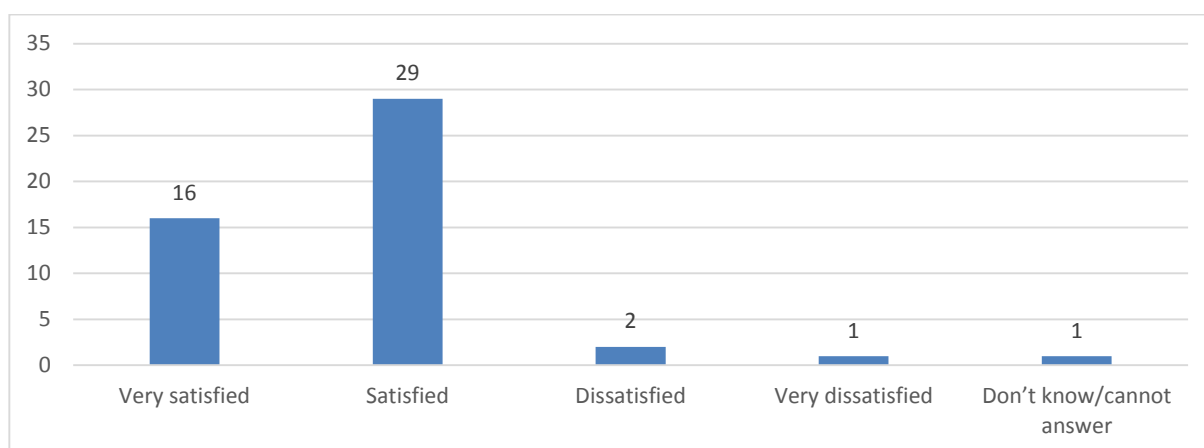


Note: Members of the SJU were more inclined to disagree with the statement than non-Members. Disagreement appears to be a result of H2020 rules adding overhead and complexity

E.1.1. Open Question: Please use this space to provide a reason for your opinion

Strongly disagree	The combination of SJU membership under the SES legislation and the H2020 regulation resulted in additional burden for SJU members, inefficient application process, high preparation effort and delay of at least 1,5-2 years before the community was able to start working
	H2020 rules is felt as a more bureaucratic step, less flexible and adapted JUs (Industrial research) and to SESAR JU and its members for coping with the ATM complexity (technical wise and actors wise). For various reason, the 'PPP' nature could not be recognised as special and definitively different form traditional research, and, mechanism to strict application of H2020 could not been avoided!
	If the comparison is between SESAR1 and SESAR2020 financial framework, H2020 rules are not made for a PPP. So the new financial framework is not an improvement but a big overhead
Slightly disagree	Horizon 2020 framework does not really support JUs and the coordination of dependent projects
	It's not about the SJU or the people working there, it's more about the H2020 framework not being appropriate for this kind of research programme.
	Procedures applied by SESAR JU under FP7, also if non-standard with respect to other FP projects, were mainly focused on technical advancements, while administrative and procedural aspects were simpler than those of other FP7 projects. This was a positive aspect in my opinion with respect to new situation.
	the SJU has now fully adopted the H2020 working mechanisms, but still maintains some aspects of the old SJU. I would recommend a full transition to H2020. This has resulted in some unnecessary lengthy processes, and duplication of documents.
Slightly Agree	Improved project structure but additional H2020 rules sometimes contradictory
	The FP7 SJU was already working well, and it continues to be working well under H2020. We are mainly involved in SESAR Exploratory Research. We've seen an improvement regarding links between SESAR Exploratory Research and Industrial Research, but there is still room for improvement in this respect.
	The programme itself is an improvement. However, it remains difficult to actively participate if research establishments do not have a significant and dedicated budget. Compared to the funding rules under FP7, those under Horizon 2020 have strongly increased the financial contribution that organisations are required to bring themselves, making it more difficult for such organisations, to participate to H2020.
	More direct contact and personalised assistance in FP7. Clearer aims of the Work programme.
Strongly Agree	Better communication, same administrative processes as H2020 (VERY IMPORTANT) and same tools to support proposal preparation
	More transparent and procedures aligned with H2020
	much better structured; methods clear from beginning; very good partnership established
	The second JU is much more Professional and predictable

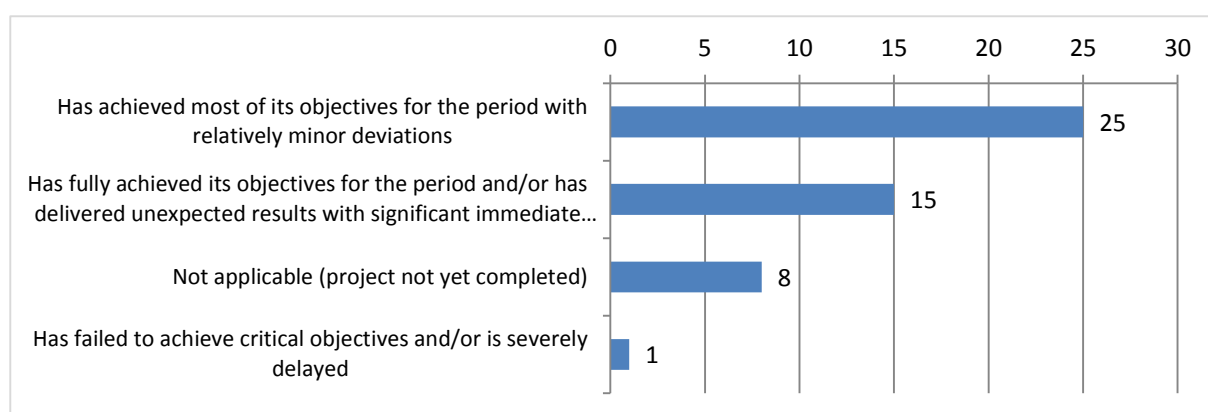
E.2. Overall, how satisfied are you with the JU's services?



E.3. Open Question: General comments or suggestions about the process of applying to the JU, or its management or administration, which have not been addressed in this survey?

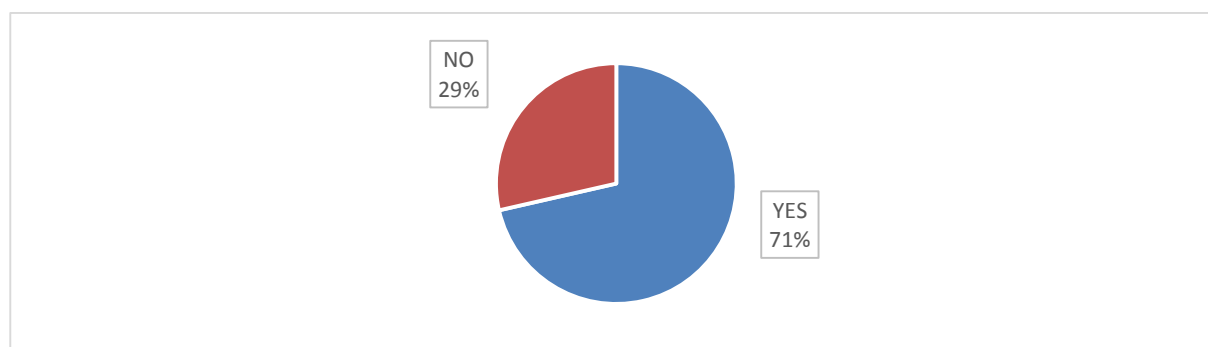
<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
Rules and requests are not fully transparent and consistently applied along all the projects of the program
It's not really about the SJU but rather its "placement" in H2020 which seems not to fit. The SJU and (most of) its people are still more or less the same but the regulatory and administrative framework is completely different.
Overall balance / duties between service providers and industry should be improved and mechanism to enforce 'progress' towards more innovative solution should be incentive at funding access level.
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
Some improvements in the SJU extranet to better identify valid information from obsolete documents (e.g. multiple versions of documents, etc...)
Information about the calls for proposals should be announced earlier: the calendar of H2020 calls is known more in advance and draft programmes are typically circulated well before the call, which allows participants to better plan their work. This is more difficult to do with SESAR Exploratory Research calls, which lack a clear calendar. Also, visibility about ongoing projects should be improved.
As compared to previous SESAR projects, there seems to be less attention to the actual technical-scientific work and more to the formal bureaucratic aspects. This may be due to the workload of POs. There was also a process of providing support from independent experts, which was very useful and it is no longer in place. The interaction with the domain experts is sometimes too superficial.
<b>Private, not-for-profit sector, e.g. research foundation</b>
Throughout one of my projects, I was asked by SJU people to align with other activities done within the SJU (in the main stream). Nevertheless, we were not able to access to ANY SJU reserved documents. It was plainly impossible.
<b>Public or government sector, e.g. research performing organisation</b>
Less complicated top down Management processes and a bottom up Partner/funding competition. With IR/VLD the Partners and their funding was decided before the Project plan and the Partners contribution were known.
The strict application of H2020 rules is sometimes not optimal for a Joint Undertaking (more overhead)
Full Budget delegation to the SJU should avoid annual grant agreements
A possible field for improvements, specific instruments better supporting partner's identification and partnership composition for proposals submission.
SJU could and should answer questions more quickly, without the delay encountered when using the official Q&A-tool.

## 17.7. **Part F: Overview of the project(s) objectives and impacts**



F.1. Overall, the project:

F.2. Did the project(s) directly contribute (expected to contribute) to new products and services for your organisation?



F.2.1. Please provide your view to the following aspects:

	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
F.2.1.1. Project directly contributed (expected to contribute) to new products and services for your organisation	12	21	1	0
F.2.1.2. The developed products and services have been taken up (expected to be taken up) in the mainstream JU activity	9	12	7	2

Note: All responses from industry providing an in-kind contribution agreed with both statements. Disagreement appears to be linked with specific WP E activities.

F.2.2. Please use this space to write about other aspects not mentioned above

<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
Taking the current project as an example, the steer and support from SESAR JU so far has been noteworthy, particularly for the motivating us to develop the project outcome to achieve potential candidacy for future deployment mission (DM). It clearly demonstrates that the objectives of JU is same as the industry, actively seeking to take the study outcomes for industrialization and operational realization.
In applied research (manage through Industrial research and VLD) which is the aim of SJU, members representing the service providers should involve more operational people and augment creativity for ATM transformation (and automation). This is key to restore Airspace Users confidence.
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
For Question F2.1.: some activities contributed directly to new products, others are far away from productisation
Project was focussed on basic research, difficult to have a direct contribution to new products and services
LSDA and VLDs are of special value to support the preparation of new products, as a unique opportunity to bring together industry and end-users in a live operational context.
This answer depends on the type of projects. No structured link with the mainstream JU activity is currently there.
<b>Private, not-for-profit sector, e.g. research foundation</b>
In spite of several interesting results (as a proof of that, I've been invited to give several talks in events), it seems that the mainstream SJU has just stored and forgot them...
<b>Public or government sector, e.g. research performing organisation</b>
Some projects, e.g. IMET, did achieve interesting results unexpected in the proposal period, but as a result of this did not achieve all intended goals. These results, although adopted by industry (Sabre), are yet to be incorporated in new NLR services and/or products.

F.3 Based on your experience, how much do you agree/ disagree with the following statements about the impact of the project(s) to your organisation?

	Strongly agree	Slightly agree	Slightly disagree	Strongly disagree
F.3.1. Project was (is) aligned to the core business of my organisation	25	20	3	1
F.3.2. Project led (is expected to lead) to the establishment of new business relationships for my organisation	16	24	5	2
F.3.3. Project augmented (expected to augment) the capability of my organisation	14	30	3	1
F.3.4. Project required (will require) the development of new skills in my organisation	11	20	13	2

**F.4. Open Question: General comments about the project(s) objectives and impacts**



<b>Private industry contributing/having contributed in-kind to SESAR project(s)</b>
There's a wide variety of projects in both SESAR1 and SESAR2020 where the best case is reflected in F.3. above. There were also many cases where old research was done again or topics were only addressed to keep people busy.
Project is leading to a study outcome that recommends how best the space based aircraft surveillance technology could help in the airspace management, in particular for aircraft separation minima. Persistent and global aircraft surveillance is now deemed an important requirement both for the safety and economic/operational performance improvements. The outcome of the study will give deeper insights into the service and performance requirements to meet the future ATM.
The consortia setup promoted by the SJU (e.g. airlines and ANSPs) promote the mutual cooperation beyond the project life,
<b>Private industry (including SMEs) benefitting/having benefitted from SESAR JU funding</b>
Project's objectives were to demonstrate potential effectiveness on RNP APCH operations, and based on its results airline has started process to add RNP APCH operations in operations and ATC is planning RNP APCH implementation in the airport where demonstration took place.
The TOPMET and TOPLINK projects have been key to support the launch of a new product within industry. Thanks for the real support provided by the SJU !
<b>Public or government sector, e.g. research performing organisation</b>
The process of identifying objectives of the core SJU partners has been a little confused. It could be useful to have a clear process more easily accessible to also small partners.
ATM still seems to regard MET support to ATM R&D a low priority. For instance, WP-E.02.40 "IMET" as well as WP11.2 "Meteorological Services" clearly illustrate how meteorological information can be used beneficially in ATM decision support. Compliments to SJU for addressing MET already in the early stages of SESAR2020 (PJ18.04).

### **17.8. Part G: Level of satisfaction with the content of the programme**

	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
G.1. How satisfied are you with the SESAR JU programme content in respect to its state-of the-art?	11	33	3	0
G.2. How satisfied are you with the SESAR JU programme content in respect to its relevance for the European aviation industry and society?	13	31	4	0
G.3. How satisfied are you with the prescriptiveness of the calls for proposals?	3	35	7	0

G.4. Open Question: Please use this space to provide a reason for your opinion

Responses ordered by level of satisfaction from Very Satisfied to Dissatisfied	<p>Considering the amount of own investment required from industry, it is key to ensure:</p> <ul style="list-style-type: none"> <li>- the adequate flexibility in projects' contents and partnerships</li> <li>- the minimum possible administrative overhead in managing projects</li> </ul>
	Initial performance improvement ambitions set too high in some cases.
	Having the SESAR R&D program a very wide scope in a relatively short period of time, it's not reasonable to expect that all different R&D elements can be delivered with the contents and within the time initially planned. In order to avoid failures in the industrialization phases a sound R&D V&V process should not be under evaluated. THE SJU approach to promote very large demonstration campaigns is a sound risk reduction measure.
	The sometimes too extensive amount of documentation (and thus the significant effort required to keep up-to-date with latest status) is reason for not selecting "Very satisfied" option.
	Maybe there is room for an overall lessons learned page (or forum) on the SJU extranet, where details of problems encountered in the process (of SESAR) are presented (or discussed).
	Regarding answer to G.3.: The Airspace User involvement in the SESAR2020 program seem unclear, with the need for multiple applications (e.g. by projects). It seems also unclear for some projects how to involve Airspace Users experts. While the organization of Airspace User involvement has always been a complex matter, it is important that end user involvement is considered early enough to ensure the quality, objectiveness and suitability of the solutions.
	Ground industry (service provider, manufacturing) is 'shy' in proposing innovative operational improvements, not providing convincing roadmap and not showing sufficient trust and openness between them (competition remains at stake). Involvement of non-industrial organisation into the industrial research and VLD is felt inappropriate
	<p>The approach is very technology driven and too conservative. There is little space for more disruptive proposals and no good link with the mainstream SJU activities.</p> <p>In many validation exercises, there is an unresolved tension between an engineering approach and a scientific approach. This tension may pollute the quality of both, especially when the scientific requirements come from non-academic partners. The Demo Activities show a better balance, with a clear technological focus.</p>

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