# SESAR JU Consolidated Annual Activity Report

## Year 2016

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## Abstract

This Consolidated Annual Activity Report, established on the guidelines set forth in Communication from the Commission ref.2014/9641, provides comprehensive information on the implementation of the agency work programme, budget, staff policy plan, and management and internal control systems in 2016.

The SESAR Solutions delivered in 2016 with maturity "available for industrialisation" are presented in this report.

As 2016 was the year of completion of the SESAR 1 programme, this report contains in its annex the Close-out Report of SESAR 1.

Founding Members

EUROPEAN UNION    EUROCONTROL

SESAR
JOINT UNDERTAKING

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# Foreword

## *Delivering the digital revolution in air traffic management*

SESAR is one of the most innovative projects that the EU has ever seen, which is largely thanks to the successful public-private partnership that the SESAR Joint Undertaking (SJU) has created. Guided by the European ATM Master Plan, a performance-drive roadmap, the SJU has successfully shown that through collaboration and technology, we can achieve the Single European Sky.

This report provides proof that this model of partnership is successful in delivering concrete solutions for take-up by aviation stakeholders in Europe and worldwide. I am confident that with the renewed and evolved partnership, the SESAR 2020 work programme will deliver even more outstanding and timely results than before and drive our ambitious aviation agenda forward.

*Henrik Hololei, Director General of the European Commission's Directorate General of Transport and Mobility (DG MOVE) and Chairman of the SJU Administrative Board*

Digital technologies are radically changing the way we live our lives and the way we do business in every way. The EU Aviation Strategy recognises the potential of digitalisation and emerging innovations to offer smarter, cleaner, and more efficient air transport systems, as well as tailor-made services for end-users. The strategy rightly sees the Single European Sky and more specifically SESAR as catalysts for transforming this vision into a reality.

2016 exemplifies just how effective the SESAR Joint Undertaking and its members have been in fast-tracking this digital transformation in air traffic management, a key element of the aviation value chain. In the space of just one year, we brought to a successful close some 270 projects – the culmination of thousands of hours of research, validations and demonstrations - resulting in more than 60 solutions addressing airport, air service and network operations, as well as the underpinning technology infrastructure. This milestone is all the more impressive given the safety criticality of the industry and the slow pace that technology change used to have in ATM before the SJU was established.

Captured in the first edition of the SESAR Solutions Catalogue, these solutions are real game-changers for increasing the capacity of Europe's airports and airspace, enabling greater connectivity and mobility between regions, all the while ensuring better value for money and reducing the environmental impact of aviation. This report not only gives details of the performance benefits that these solutions offer, but also the considerable return on the initial research investment that they are bringing as and when they are deployed.

2016 also showed that there is a real appetite to go much further in this transformation work. With the launch of SESAR 2020, we have extended our membership to 19 members representing more than 100 companies across the industry. Together the aim is to further explore disruptive technologies, including virtual centres, remote towers and satellite-based solutions, as well as emerging challenges such as the integration of drones alongside more conventional air traffic, and

cyber-security of more interoperable systems. Two of the programme's three research strands – exploratory and industrial – were kicked off by the end of the year, while the publication of a call for very-large-scale demos set in motion this important innovation stream.

Air traffic management is clearly on the cusp of change. The SJU is leading the way in this endeavour and remains committed to delivering high performing aviation in Europe.

***Florian Guillermet, Executive Director, SESAR Joint Undertaking***

## Administrative Board's analysis and assessment

The Administrative Board has assessed the SESAR Joint Undertaking's Consolidated Annual Activity Report for 2016 (CAAR 2016) and, having reviewed the document, notes that:

- The SJU met its key policy and operational objectives as outlined in the 2016 Annual Work Programme;
- The SJU's key achievements in 2016 were the following:
  - Completion and closure of SESAR 1 (the first European research and innovation programme on Air Traffic Management, covering the period 2008-2016),
  - Ramp-up of SESAR 2020 (the second European research and innovation programme on Air Traffic Management, covering the period 2014-2021),
  - Effective stakeholder engagement by the SJU,
  - Assistance to stakeholders in other areas concerning the technological pillar of Single European Sky,
  - Continued provision of an effective organisation to support delivery of SJU's mandate;
- The SJU used its resources in line with the activities as described in the work plan;
- The performance indicators show that overall the targets were met;
- Internal control and management systems were in place and working adequately;
- The required building blocks of assurance (management assessment, exception register, audits etc.) have been in place all along the year 2016;
- The main risks for the delivery of the SJU's key objectives were identified and the relevant mitigating measures taken, keeping overall risks under control and at an acceptable level of criticality.

Consequently, the Administrative Board concludes that the CAAR 2016 accurately and adequately describes the work performed by the SJU in 2016.

# Executive summary

## SESAR KEY FACTS & FIGURES

Aviation, supported by air traffic management (ATM), is a key driver of EU economic growth, jobs and trade, and essential for the life and mobility of its citizens. However, the current ATM system is highly fragmented and reliant on ageing technology, leading to inefficiencies of EUR 4 bn annually. The role of SESAR is to define, develop and deploy what is needed and build a more connected greener, safer ATM system for Europe in aviation and air transport.

The aviation industry employs around 1.4m people and supports between 4.8 and 5.5m jobs.

The aviation contributes an overall impact of EUR 110bn to the EU's GDP[1].

### SESAR'S THREE PHASES

2005    2008

2024

2035

**DEFINITION PHASE**
- A roadmap for ATM modernisation
- Meeting the performance objectives of the Single European Sky
- Ensuring support with ICAO's global air navigation plan

**SESAR DEVELOPMENT**
- Exploring & developing new operational & technology Solutions
- Validating & demonstrating benefits in real-operational environments
- Delivering a catalogue of solutions to transform ATM

**SESAR DEPLOYMENT**
- Implementation of SESAR Solutions to answer local needs
- Synchronised deployment to deliver Europe-wide benefits

### SESAR JOINT UNDERTAKING

A unique public-private partnership, in place since 2007, uniting:

2 founding members: EU and Eurocontrol

19 industry members

100+ companies from across air traffic management

60+ universities, research centres and SMEs

3.000 experts from aviation and ATM

**Digitisation**
Remote tower & virtual tech rollout, better info exchange and cross-border collaboration, all air vehicles (including drones) integrated into Europe's airspace

**BENEFITS**
SESAR offers benefits in several key areas:

**Investment**
- EUR 1.6bn in R&D through SESAR 2020
- EUR 3.8bn for EU-wide deployment solutions (2024-2015) generating EUR 12.1bn in performance gains

**Decarbonisation**
Greener flight routes, 500-250kg fuel savings per flight & 10kg per passenger

**People**
Shorter travel times, better mobility & connectivity, less noise & congestion round airports, consumer savings, 4-3 times better safety.

1 European Commission aviation sector

Founding Members

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2016 was an exceptional year for the SESAR Joint Undertaking (SJU), who, together with its Members, conducted two programmes in parallel. Meanwhile, the SJU continued to steer the modernisation of air traffic management in Europe. During this important year, the SJU planning, as defined in the Annual Work Programme 2016[1] endorsed by the Administrative Board, focused on achieving 5 core objectives:

- Completion and closure of SESAR 1,
- Ramp up of SESAR 2020,
- Effective stakeholder engagement by the SJU,
- Assist stakeholders in other areas concerning the technological pillar of Single European Sky,
- Continued provision of an effective organisation to support delivery of SJU's mandate.

This document presents the achievements of the year 2016 in comparison with the above mentioned objectives, and provides an evaluation by the Management on the overall activities carried out by the SESAR JU.

**Completion and closure of SESAR 1**

In 2016, the SESAR JU and its Members sustained a significant effort to pursue the delivery of the SESAR 1 programme. The SESAR Solutions delivery process accelerated: in the Release #5, projects deliverables were packaged in 36 new SESAR Solutions assessed to be "available for industrialisation" through validation exercises conducted all over Europe. In total, there are 61 performance-driven Solutions which have been produced and assessed "available for industrialisation" through the SESAR 1 programme from 2008 to 2016. The development of 54 other Solutions started under SESAR 1 will continue in the context of SESAR 2020.

At the end of 2016, all SESAR 1 projects were closed from an operational standpoint. The process of assessing the Members' Interim Financial Statements for 2015 and proceeding with co-financing payments accordingly was performed in 2016.

The achievements of the SESAR 1 programme, which are presented in the Close-Out Report in annex, were presented in the context of the SESAR Showcase event with more than 500 participants. This report shows that the achievements of SESAR 1 are twofold: it has enabled air traffic management (ATM)research in Europe to break down silos and connect with international partners, and it has delivered concrete Solutions bringing performance improvement to the air traffic management system in terms of fuel consumption (-2,4% per flight), air navigation service costs (-5,3%), capacity (+38% in terminal manoeuvring area, +11% at airports, +33% in en-route) while keeping safety at its current level despite increasing traffic.

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[1] SESAR JU Annual Work Programme 2016

**Ramp up of SESAR 2020**

In 2016, the SJU renewed its membership through the signature of a new Membership Agreement with 19 organisations representing the ATM community in Europe. EUROCONTROL formally adhered to this Membership Agreement and signed a specific Agreement with the SJU including provisions on its contribution as a Founding Member of the SJU.

In 2016, further to the work already accomplished in 2015 to prepare for SESAR 2020, the SJU implemented the SESAR 2020 programme management structure and processes, fulfilling both H2020 requirements and the specific objectives of the SESAR programme. All required processes are now established and 3 new positions dedicated for SESAR 2020 processes (one of Call Coordinator and two Grant Managers) were created and filled in. Finally, results from SESAR 1 are being transferred to SESAR 2020 in order to allow for an effective transition between the two programmes, especially for further developing the performance-driven SESAR Solutions.

This allowed for the SESAR 2020 programme to start its full execution and delivery phase. Following the two H2020 calls launched in 2015, all grant agreements were settled for 28 Exploratory Research projects (for a total maximum co-financing amount of EUR 20,4 million), 20 Industrial & Validation projects (for a total maximum co-financing amount of EUR 208,8 million) and 5 Very Large-scale Demonstration activities (for a total maximum co-financing amount of EUR 37,7 million). These projects, now in full execution, delivered their first results which were received and evaluated by the SJU.

Furthermore, 2 additional calls were organised and launched:

- ER2 (Exploratory Research 2) focusing on Remotely Piloted Aircraft Systems (RPAS or drones) for a total value of EUR 9 million, launched in June and deadline in November. Evaluations of the 59 received proposals started in December;
- ER3-VLD (Exploratory Research 3 and open Very Large-scale Demonstrations) for a total value of EUR 28 million, launched and opened in December.

Therefore, at the end of 2016, the cumulative amount committed by the SJU under the H2020 programme calls, also including 2015 calls (for which evaluation is completed), is EUR 303,9 million.

As it was done under the SESAR 1 programme, the SJU will steer the SESAR 2020 programme towards the achievement of the Single European Sky objectives, managed through the European ATM Master Plan. After the adoption of the new edition of the European ATM Master Plan in late 2015, the subsequent  update of Levels 2 (Planning & Architecture) and 3 (Implementation) was conducted in 2016.

Lastly, the ramp-up of SESAR 2020 required adapting the governance structure to the new Programme and renewed SJU Membership:

- Renewal of the Administrative Board membership,
- Renewal of the Programme Committee membership, and installation of 2 sub-committees: the Delivery Management Sub-Committee and the Operational & Technical Sub-Committee,
- Renewal of the Scientific Committee membership,
- Installation of the new ATM Master Planning Committee.

## Effective stakeholder engagement by the SJU

Besides its role in steering the SESAR 1 and then SESAR 2020 programme, the SJU has the mandate to engage with European and international stakeholders for the modernisation of European air traffic management.

In the context of the installation of SESAR 2020, and continuing of cooperation within the previous programme, the SJU established new working and collaboration arrangements with third-party stakeholders: European Aviation Safety Agency (EASA), European Defence Agency (EDA), European Space Agency (ESA), Airports Council International (ACI), Clean Sky, Civil Airspace Users, Professional Staff Associations, National Authorities…. Moreover, the SJU maintained its close cooperation with the US Federal Aviation Administration (FAA) and its NextGen programme; the SJU and FAA jointly published the second edition of the NextGen-SESAR State of Harmonisation document in November 2016. The collaboration with the SESAR Deployment Manager continued both on a day-to-day working level and at a higher level in the Steering Committee of the 2015 signed memorandum of understanding between the SJU and the SESAR Deployment Manager. In September 2016, the SJU signed a Memorandum of Cooperation with the General Civil Aviation Authority (GCAA) of the United Arab Emirates, to share information, knowledge and expertise between both parties and to co-operate in activities related to ATM modernisation.

In order to continuously maintain a high profile and engagement with relevant stakeholders across the ATM community, the SJU organised major events in 2016 such as the SESAR Showcase (over 500 participants, presenting the achievements of SESAR 1 and bridging to SESAR 2020) and the global SESAR-Wide Information Management Workshop (over 150 partners involved).

Furthermore, the SJU released its first edition of the SESAR Solutions Catalogue, presenting more than 60 SESAR Solutions delivered by SJU members and partners to modernise Europe's air traffic management system. This first edition covers fully validated and documented Solutions, most of them confirmed as ready for implementation, and ranging from quick-win Solutions to those that address more complex operations.

## Assist stakeholders in other areas concerning the technological pillar of Single European Sky

In 2016, the SJU continued to assist its stakeholders on a number of areas relating to the technical contribution in other areas of the Single European Sky initiative: this included technical assistance on specific tasks such as Datalink (ELSA study), SESAR-Wide Information Management (SWIM), Cyber-security (a study on cyber-security at airports was delivered in November 2016 applying SESAR security risk assessment methodology to investigate cyber-security risks at an Airport Operations Centre), drones and Communication, Navigation & Surveillance (CNS), amongst others.

In the particular field of drones, two major achievements need to be highlighted: the "SESAR European Drones Outlook Study" was made public in November 2016, and the European Parliament assigned a budget of EUR 500,000 for Very Large-Scale Demonstrations on geofencing.

**Continued provision of an effective organisation to support delivery of SJU's mandate**

Lastly, the SJU continued to fulfil its duties in corporate, financial, legal and human resources management. Main achievements in this area are: the commitment of operational budget for the ongoing and new calls, the conclusion of a large procurement contract in support to operational activities, the alignment with regular calendar for the programming and reporting documents, the adoption of the Anti-Fraud strategy, the implementation and launch of the SJU Quality Management System and the migration of the ICT infrastructure and support services under a new service contract through EUROCONTROL.

In 2016, the European Parliament granted discharge to the SJU regarding financial year 2014.

**Management assessment**

As in previous years, the SESAR JU conducted regular monitoring of risks and of assessment with regard to Internal Control Standards. In this area, no non-compliance has been reported, but improvement points are identified in the fields of Information and Document Management especially (with an action plan in progress).

Furthermore, recommendations from Audits in previous years (from both the Internal Audit Service and the European Court of Audit) resulted into action plans which were implemented or are in progress.

## 2016 Highlights



### 2016 HIGHLIGHTS

**JAN** — **Expert studies published** identifying by when datalink technology for aviation would reach its operational limits in Europe, and offering recommendations on **how to address performance issues related to datalink and alternatives to the technology**

**MAR** — **SESAR 2020 membership renewed,** bringing **19 entities** together to work on air traffic management (ATM) research and innovation

**19 MEMBERS**

**MAY** — **63 SOLUTIONS IN SESAR 1** **First SESAR Solution Catalogue** published, capturing **63 solutions delivered** to date by the SESAR Joint Undertaking

**JUN** —
- **First SESAR 2020 exploratory research projects** launched with **EUR 20.4 million** in funds under EU's Horizon 2020
- **SESAR SWIM Global** in Rome and **SESAR Showcase** in Amsterdam demonstrated these solutions and the power of partnership

**SEP** —
- **Drone demonstration project summaries** published showing how these vehicles can be safely integrated into civil airspace
- **SESAR Drone Outlook Study published,** providing a snapshot of the drone landscape in 2050 and how new markets will unfold

**OCT** — **€260 M** **First wave SESAR 2020 industrial research and large-scale validation tests** get underway with **EUR 260 million** funds from SESAR members and Horizon 2020

**DEC** — **SESAR Phase 1 R&I activities formally closed** the remaining **270 projects,** amounting to **1,222 deliverables** and 160,000 man days of work

**270 PROJECTS** **1,222 DELIVERABLES** **160,000 MAN DAYS**

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# Introduction

## Background and objectives of this document

The SESAR Joint Undertaking established this Consolidated Annual Activity Report (CAAR) in accordance with Article 66(9) of the EU Financial Regulation[1] and Article 47 of the Framework Financial Regulation[2], Article 16 of the Statutes of the SESAR JU[3], and of Article 46 of the Financial Rules[4] of the SJU.

This Consolidated Annual Activity Report has several purposes: it provides evidence of progress toward achieving the SJU's key objectives as defined in the 2016 Annual Work Programme, taking into account resources used during the reporting period. It also outlines the management and oversight systems in place at the SJU, including reference to the European Commission's Internal Control Standards. Lastly, it also includes a declaration of assurance in which the Executive Director, in his role as Authorising Officer, provides assurance as regards the true and fair view given by the report and pertaining to the legality and regularity and the sound financial management of all transactions under his responsibility.

This Consolidated Annual Activity Report follows the guidelines set forth in Communication from the Commission on the guidelines for programming document for decentralised agencies and the template for the Consolidated Annual Activity Report for decentralised agencies[5].

## The SESAR JU: a key constituent of the EU Aviation Strategy

Aviation, in particular Air Transport supported by air traffic management (ATM), is a key driver of EU economic growth, jobs and trade, and essential for the life and mobility of its citizens. However, the current ATM system is highly fragmented and largely reliant on ageing technology, leading to inefficiencies evaluated at an amount of EUR 4 billion annually.

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[1] 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. OJ L 298, 26.10.2012

[2] Commission Delegated Regulation (EU) No 1271/2013 of 30 September 2013 on the framework financial regulation for the bodies referred to in Article 208 of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council

[3] Annex to 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)

[4] Administrative Board decision ADB(D) 08-2015

[5] Communication from the Commission (2014) 9641 final on the guidelines for programming document for decentralised agencies and the template for the Consolidated Annual Activity Report for decentralised agencies

Founding Members

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In December 2015, the publication of "An Aviation Strategy for Europe" [6] provided additional focus and momentum towards completion of the Single European Sky (SES) to generate growth for European business, foster innovation and let passengers profit from safer, cleaner and cheaper flights, while offering more connections. The Strategy contributes directly to the Commission priorities of Jobs and Growth, Digital Single Market, Energy Union and the EU as a global actor, and the SESAR project and the SESAR JU are key components enabling the implementation of the Strategy's objectives.

The Single European Sky (SES) legislative framework aims to the achievement of the following High-Level Goals:

- Enable a three-fold increase in capacity which will also reduce delays both on the ground and in the air;
- Improve safety by a factor of 10;
- Enable a 10 % reduction in the environmental impact of flights;
- Reduce the cost per flight by 50 %.

The SESAR Project, through its definition, development and deployment processes, aims at delivering the operational procedures and technologies necessary for a new and global interoperable concept of ATM, built around a continuous sharing of data between aircraft, air navigation service providers and airports.

The SESAR JU acknowledges the objectives for the modernisation of ATM as defined in the SES. To this end, SESAR also remains a flagship project identified within the 'FlightPath2050' report, a roadmap for the provision of a clean, competitive, safe and secure European aviation industry prepared by the High-Level group on Aviation Research. SESAR's positive contribution to meeting the needs of citizens, markets and to maintaining a competitive advantage for Europe is key to the continued successful evolution of ATM.

## The composition of the SESAR JU

The SJU was created under Article 171 of the Treaty establishing the European Union to provide an effective coordination role for all relevant research and development efforts within the European Union. Its mandate and mission is coherent with the 4 long-term strategic objectives set by the SES initiative.

Founded by the European Union and EUROCONTROL, established in 2007 as a joint undertaking[7], the SESAR JU became a Union Body in 2009. It was augmented by 15 stakeholder Members and then in

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[6] http://ec.europa.eu/transport/modes/air/aviation-strategy

[7] The SESAR Joint Undertaking (SJU) was established under Council Regulation (EC) 219/2007 of 27 February 2007 (as modified by Council Regulation (EC) 1361 / 2008 (SJU Regulation) and last amended by the Council Regulation (EU) 721/2014)

2016 a further 4 members acceded to membership, all committing to further achieve the mission of the Joint Undertaking to 2024.



**Figure 1: Composition of the SESAR JU from 2016 onwards**

Together with their partners and affiliates, the Members represent over 100 organisations from across the ATM community, from civil and military air navigation service providers, to airports, civil and military airspace users, staff associations, academia and research centres. Through these partnerships and further collaboration with staff associations, regulators and the larger scientific community, the SESAR JU unites the skills of some 3,000+ experts to fast-track and focus research leading to change in European ATM.

## The role and missions of the SESAR JU

Within the SES, the challenges for ATM are captured and maintained by the SJU in a European ATM Master Plan (currently 2015 Edition) which forms the main planning tool for ATM modernisation in Europe. The role of the SESAR JU in steering the SESAR R&I programme, is to define and develop solutions that meet what is needed and build a more connected, greener, safer ATM system as well as ensuring this is standardised as needed and made globally interoperable. Much of this work has been undertaken since 2008 through the SESAR R&I programme (called SESAR 1 for the period covering 2008 to 2016, and SESAR 2020[8] for the period covering 2015 to 2021), coordinated by the

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[8] The SESAR 2020 activities performed by industry are funded through the Horizon 2020 Framework Programme for Research and Innovation (H2020), which means that the SESAR JU implements the SESAR 2020 programme in accordance with Horizon 2020 rules for participation and dissemination for all its activities related to award and management of these grants

SESAR JU and performed by the industry at large. The SESAR JU transfers the result of its ATM Research and Innovation activities in the form of SESAR Solutions that are made available for deployment, and therefore makes a positive contribution towards the achievement of the Single European Sky. This relationship between the SES objectives, the ATM Master Plan defining the medium and long-term planning of achievements, and the R&I activities delivering SESAR Solutions transferred from deployment, is structured in the SESAR Innovation Pipeline which is depicted in the figure below:
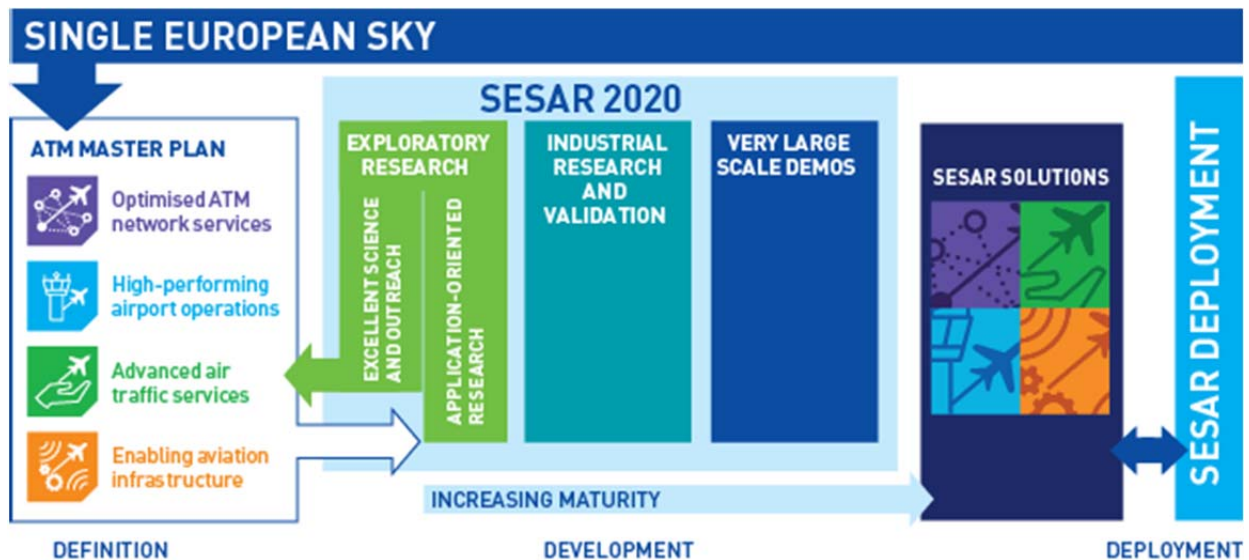


**Figure 2: The SESAR Innovation Pipeline – from the Single European Sky policy to SESAR Solutions**

In figure 2, three levels of Research and Innovation are presented, corresponding to different levels of maturity of the research outcomes, each having specific arrangements for calls:

- The **Exploratory Research (ER)** addresses relevant fundamental scientific subjects representing transversal topics for future ATM evolution ('Excellent Science & Outreach') investigates the initial applications of such science for the ATM sector (Application-oriented research) and application-oriented research. Exploratory Research covers research activities up to TRL 2[9]. This phase of research is wholly funded from EU funds and done in full compliance with H2020 and "the rules of participation". It is subject to open calls;
- Through the **Industrial Research and Validation (IR)**, which includes applied research, pre-industrial development and validation projects, SESAR Solutions are developed and, through validation exercises, their maturity and potential benefit is assessed in the context of yearly Releases (one per year). IR covers research activities up to TRL 6. Calls related to IR are restricted to the SJU Members.

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[9] As required by Horizon 2020, the maturity of research outcomes is assessed according to the Technology Readiness Level (TRL) model, combined with the European Operational Concept Validation Methodology (E-OCVM) model to allow for the assessment of technological and operational concept developments

- The third phase deals with **Very Large-Scale Demonstration activities (VLDs)** which are designed as demonstrations of particular programme concepts elements and SESAR Solutions. These demonstrations provide the bridge between the development and deployment phases of SESAR and are delivered through work undertaken by SJU Members (through restricted calls), supplemented by open calls to ensure the widest possible stakeholder participation.

Solutions which are assessed with TRL 6 level of maturity and a positive cost-benefit analysis are then transferred for deployment, either through Common Projects, or through uncoordinated deployment.

Additionally, the SJU assists all its stakeholders on relevant subjects relating to SES's technological pillar, providing independent support and advice in areas where there is a link between SESAR deliverables and any initiatives that demonstrate a high level of interdependency with SESAR project objectives.

Besides the role of technology and innovation, the EU Aviation Strategy also recognises the need to secure Europe's leading role in international aviation. To this end the SESAR JU also works closely with the European Commission, EUROCONTROL and EASA on building and executing a coordinated plan of action involving third countries and the international aviation body ICAO.

The way in which the SJU delivers its work is changing. While SESAR 1 was funded through FP7 and TEN-T, the introduction of H2020 in 2014 has required a change not only in funding but also fundamental adjustments in organisational structure and ways of working. In particular, it has been necessary for the SJU to look in detail at the scope of application of the Horizon 2020 Framework Programme and Horizon 2020 Rules for participation and dissemination in relation to SJU's activities and their applicability to the exploratory research activities and applied research, pre-industrial development and large-scale demonstrations that the SJU manages[10]. A number of the achievements of 2016 are related to this need and to making the parallel operation under 2 different frameworks (SESAR 1 and SESAR 2020) possible.

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[10] On the basis of the performed analysis it has been concluded that Horizon 2020 rules fully apply to SESAR JU without derogations whilst remaining in compliance with the SJU Founding Regulation

## Factsheet: the SESAR JU in 2016

The table below provides an overview of key facts and figures related to the SESAR JU structure and management in 2016:

| Name | SESAR Joint Undertaking (SJU) |
|---|---|
| Objectives | The SJU is responsible for coordinating, rationalising and concentrating all relevant ATM research and development efforts in the EU, aiming to contribute to the modernisation and harmonisation of ATM in Europe |
| Founding Legal Act | Established under Council Regulation (EC) 219/2007 of 27 February 2007[11] <br><br> Modified by Council Regulation (EC) 1361/2008 (SJU Regulation)[12] <br><br> Last amended by Council Regulation (EU) 721/2014[13] |
| Executive Director | Florian Guillermet (mandate running up to March 2022) |
| Administrative Board composition[14] | **Members with voting rights:** <br><br> A) SJU Members <br><br> • European Union (Founding Member) <br> • EUROCONTROL (Founding Member) <br> • Airbus <br> • AT-One consortium <br> • B4-consortium <br> • COOPANS Consortium <br> • Dassault Aviation <br> • DFS <br> • DSNA |

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[11] 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)

[12] Council Regulation (EC) No 1361/2008 of 16 December 2008 amending Regulation (EC) No 219/2007 on the establishment of a joint undertaking to develop the new generation European air traffic management system (SESAR)

[13] Council Regulation (EU) No 721/2014 of 16 June 2014 amending Regulation (EC) No 219/2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR) as regards the extension of the Joint Undertaking until 2024

[14] As at 31 December 2016. The list of participants to the Administrative Board is provided in annex IX. Before 2016, the SJU membership was composed of the 2 Founding Members (EU and EUROCONTROL) and 15 additional Members

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| | • ENAIRE<br>• ENAV<br>• Leonardo<br>• Frequentis Consortium<br>• Honeywell<br>• INDRA<br>• NATMIG<br>• NATS<br>• SEAC 2020<br>• Skyguide<br>• Thales Air Systems SAS<br>• Thales Avionics SAS<br><br>B) Representative at European level of civil users of airspace<br><br>**Members without voting rights:**<br><br>• Military<br>• Air Navigation Service Providers<br>• Equipment manufacturers<br>• Airports<br>• Staff in the ATM sector<br>• Scientific community |
| Other Governance Bodies | The Programme Committee (PC)<br><br>The Scientific Committee (SC)<br><br>The Master Planning Committee (MPC) |
| Human Resources[15] | 44 positions:<br><br>• Temporary Agents: 39 positions<br>• Contract Agents: 2 positions (temporary in 2016 and 2017)<br>• Second National Experts: 3 positions |

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[15] As at 31 December 2016. Details on the implementation of the Staff Establishment Plan are provided in section 2.4

Founding Members

| 2016 Budget | Budget revenue: EUR 99.073.761 <br><br> • EU contribution: EUR 62.138.000 (SESAR 2020) <br> • Other revenue: EUR 36.935.761 (SESAR 1) <br><br> Revenue payment appropriations: EUR 146.753.830 (of which 56.519.225 is SESAR 2020 budget) <br><br> Budget expenditure: <br><br> • Commitments: <br><br>     o Title I (staff expenditure): EUR 6.191.500 <br>     o Title II (infrastructure and operating expenditure): EUR 4.058.500 <br>     o Title III (operational expenditure): EUR 88.823.761 (of which EUR 62.138.000 is SESAR 2020 budget) <br><br> • Payment appropriations: <br><br>     o Title I (staff expenditure): EUR 6.191.500 <br>     o Title II (infrastructure and operating expenditure): EUR 4.058.500 <br>     o Title III (operational expenditure): EUR 146.902.638 (of which EUR 56.519.225 is SESAR 2020 budget) |
|---|---|
| 2016 Budget implementation | Implementation of budget revenue: EUR 143.212.022 <br><br> • EU contribution: EUR 131.519.225 (of which EUR 56.519.225 is SESAR 2020 Budget) <br> • Other revenue: EUR 11.692.797 <br><br> Implementation of budget expenditure: <br><br> • Actual commitment appropriations: <br><br>     o Title I (staff expenditure): EUR 6.172.482 <br>     o Title II (infrastructure and operating expenditure): EUR 3.666.907 <br>     o Title III (operational expenditure): EUR 87.274.264 (of which EUR 61.638.000 is SESAR 2020 budget) <br><br> • Actual payment appropriations: <br><br>     o Title I (staff expenditure): EUR 5.018.626 <br>     o Title II (infrastructure and operating expenditure): EUR 2.711.600 <br>     o Title III (operational expenditure): EUR 95.243.002 (of which EUR 49.919.493 is SESAR 2020 Budget) |

| | |
|---|---|
| Strategic Research Agenda | SESAR 2020 Multi-annual work programme: <br><br> http://www.sesarju.eu/newsroom/brochures-publications/sesar-2020-multi-annual-work-programme |
| Call implementation | SESAR 1 <br><br> • A total of 409 projects and demonstration activities (45 Exploratory Research, 322 Industrial Research & Validation projects and 42 Demonstration activities), <br> • Managed under the FP7 and TEN-T framework programmes, with 15 SJU Members as beneficiaries, <br> • Completed until 2016. <br><br><br> SESAR 2020, under Horizon 2020 framework programme: <br><br> • 2 calls launched in 2015, resulting in: <br><br>    o 28 Exploratory Research projects with the corresponding grants signed with 84 beneficiaries, for a total value of EUR 20,4 million, resulting from the open call H2020-SESAR-2015-1 <br>    o 20 Industrial Research & Validation projects with the corresponding grants signed with 20 beneficiaries (EUROCONTROL and 19 other SJU Members[16]), for a total value of EUR 208,8 million, resulting from the restricted call H2020-SESAR-2015-2 <br>    o 5 Very-Large Scale Demonstration activities with the corresponding grants signed with 20 beneficiaries (EUROCONTROL and 19 other SJU Members), for a total value of EUR 37,7 million, resulting from the restricted call H2020-SESAR-2015-2 <br><br> • 2 additional open calls launched in 2016 in view of grants settlement and launch of projects in the fields of <br><br>    o Exploratory Research on RPAS (ER2-RPAS call with reference H2020-SESAR-2016-1), for a total value of EUR 9 million <br>    o Exploratory Research (ER3 & VLD call reference H2020-SESAR-2016-2), for a total value of EUR 10 million <br>    o Very-Large Scale Demonstrations (ER3 & VLD call reference H2020-SESAR-2016-2), for a total value of EUR 18 million <br><br> • Additional calls, both open and restricted to SJU Members, are planned in the upcoming years |

**Table 1: The SESAR Joint Undertaking at end 2016 in brief**

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[16] As some SJU Members are consortia, the 19 SJU Members and EUROCONTROL represent in total 38 organisations

Founding Members

# 1 Part I: Achievements of the year

This section highlights progress towards the completion of the SJU's main objectives in 2016.

2016 was an exceptional year for the SJU, with the finalisation and operational closure of the SESAR 1 programme, and the launch of SESAR 2020 programme execution phase. During this important year, the SESAR Joint Undertaking planning, as defined in the Annual Work Programme 2016[17], focused on achieving 5 core objectives and the key related targets that were endorsed by the Administrative Board:

- **Completion and closure of SESAR 1**, with 100% of the projects closed by Q4 2016;
- **Ramp-up of SESAR 2020**, with

  - Complete Membership Accession Process and related Membership Agreements signed by end of Q1,
  - 80% of SESAR 2020 Projects started by end of Q4,
  - Launch of the SESAR 2020 RPAS Exploratory Research call by end of Q3 2016,
  - Launch of the SESAR 2020 Exploratory Research second call by end of Q4;

- **Effective stakeholder engagement** by the SJU, with the completion of the set-up of the various arrangements with third-party stakeholders (EASA, EDA, ESA, ACI, Clean Sky, Civil Airspace Users, Professional Staff Associations, National Authorities etc.) by end of Q4, and the collaboration with NextGen and the SESAR Deployment Manager effective in the beginning of 2016;
- **Assist stakeholders in other areas concerning the technological pillar of Single European Sky**, with the completion of the RPAS Outlook Study by end of Q3 and of the ELSA study on Datalink by Q4;
- Continued **provision of an effective organisation to support delivery of SJU's mandate**, with the relevant ADB and ED decisions and SJU internal procedures successfully transited to SESAR 2020 and SJU staff trained accordingly by end of Q4.

This document presents the achievements of the year 2016 in comparison with the above mentioned objectives.

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[17] SESAR JU Annual Work Programme 2016

## 1.1 Area of Operations 1: Completion and closure of all SESAR 1

> *Objective and target achievement status at the end of 2016: 100% of the SESAR 1 projects were closed at the end of Q4 2016*

The SESAR 1 programme was run by the SJU and its Members: 2 Founding Members (The European Union, represented by the European Commission, and EUROCONTROL) and 15 member organisations representing the Air-Traffic Management in Europe, including Air Navigation Service Providers, Airports, Ground Industry Manufacturers & Airborne Systems Manufacturers. In addition, a significant number of other organisations, non-Members, work with the SJU, among which more than 10 universities and research centres from 5 EU Member States and a number of Small-Medium Size Enterprises (SMEs). Furthermore, the SESAR 1 programme receives the active support of a number of organisation representing stakeholders of Air Transport in Europe: civil Airspace Users, the Military, Professional Staff Organisations, National Authorities etc. (see section 1.3). As in the previous years, in 2016 the SESAR 1 programme concentrated the ATM research and innovation in Europe and federated a large variety and diversity of organisations in ATM R&I projects.

SESAR 1 programme execution continued during the course of 2016. The SESAR 1 programme was constituted of 18 Work Packages that each addressed a piece of the work programme. These Work Packages, which altogether count 409 projects and demonstration activities of which 270 still active in 2016, are split into six separate elements:

- Operational topics (addressed under Work Packages 4, 5, 6 and 7): 88 projects, of which 64 were still active in 2016;
- Technology topics (addressed within Work Packages 9, 10, 11, 12, 13 and 15): 142 projects, of which 108 were still active in 2016;
- System Wide Information Management (SWIM) topics (addressed under Work Packages 8 and 14): 33 projects, of which 13 were still active in 2016;
- 'Transversal' activities, such as validation infrastructure maintenance, development of safety, security, environment and human performance cases, and the maintenance of the European ATM Master Plan were covered under Work Packages B, C, 3 and 16: 59 projects, of which 33 were still active in 2016;
- Exploratory Research was covered through Work Package E: 45 projects, of which 31 were still active in 2016;
- Large-Scale Demonstration (LSD) activities: 42 activities, of which 21 were still active in 2016.

As the last year of the execution of the SESAR 1 programme, 2016 was also the year of finalisation and managed closure of all still active SESAR 1 projects.

The SESAR Solution delivery process continued with the execution of Release 5 (planned in 2015), which constitutes the last Release under SESAR 1.

### 1.1.1 The achievements of the SESAR 1 programme in 2016

At 31st December 2016, all projects under these Work Packages and all Demonstration Activities were fully implemented and closed from an operational standpoint, thus concluding the implementation of the SESAR 1 programme.

Furthermore, the fifth SESAR Release (Release #5) was completed and concluded in 2016.

These activities are presented in the following paragraphs, with annex I.1.1 providing further detailed information.

### 1.1.1.1 Completion of the delivery of R&D projects under the SESAR 1 programme

To achieve this, the SESAR JU assessed a total of 1222 deliverables according to the process described in the SESAR 1 Programme Management Plan (SESAR 1 PMP):

| WBS element | Work Package | Work Package name | Active projects in 2016 | Deliverables assessed in 2016 |
|---|---|---|---|---|
| Operational Work Packages | 04 | En-Route Operations | 13 | 71 |
| | 05 | TMA Operations | 18 | 66 |
| | 06 | Airport Operations | 24 | 112 |
| | 07 | Network Operations | 9 | 46 |
| Technology Work Packages | 09 | Aircraft Systems | 20 | 125 |
| | 10 | En-Route & Approach ATC Systems | 24 | 108 |
| | 11FW | Flight and Wing Operations Centre | 6 | 31 |
| | 11M | Meteorological Services | 3 | 24 |
| | 12 | Airport Systems | 31 | 119 |
| | 13 | Network Information Management System (NIMS) | 3 | 24 |
| | 15 | Non Avionic CNS System | 21 | 138 |
| SWIM Work Packages | 08 | Information Management | 6 | 28 |
| | 14 | SWIM Technical Architecture | 7 | 40 |
| Transversal activities | B | Target Concept and Architecture Maintenance | 8 | 55 |
| | C | Master Plan Maintenance | 4 | 34 |
| | 03 | Validation Infrastructure and Integration | 10 | 53 |
| | 16 | R&D Transversal Areas | 11 | 49 |
| Exploratory Research | E | Long Term and Innovative Research Programme | 31 | 66 |
| Demonstration activities | LSD | Large Scale Demonstration | 15 | 27 |
| | RPAS | RPAS Demonstrations | 6 | 6 |
| TOTAL | | | 270 | 1222 |

**Table 2: Technical deliverables from SESAR 1 assessed by the SESAR JU in 2016**

When looking at the delivery throughout the year, the figure below shows that the SJU and its Members have continued the delivery effort to the maximum extent possible, thanks to a thorough coordination of the closure process and the delivery plans:

**Projects delivery compared to open projects in 2016**
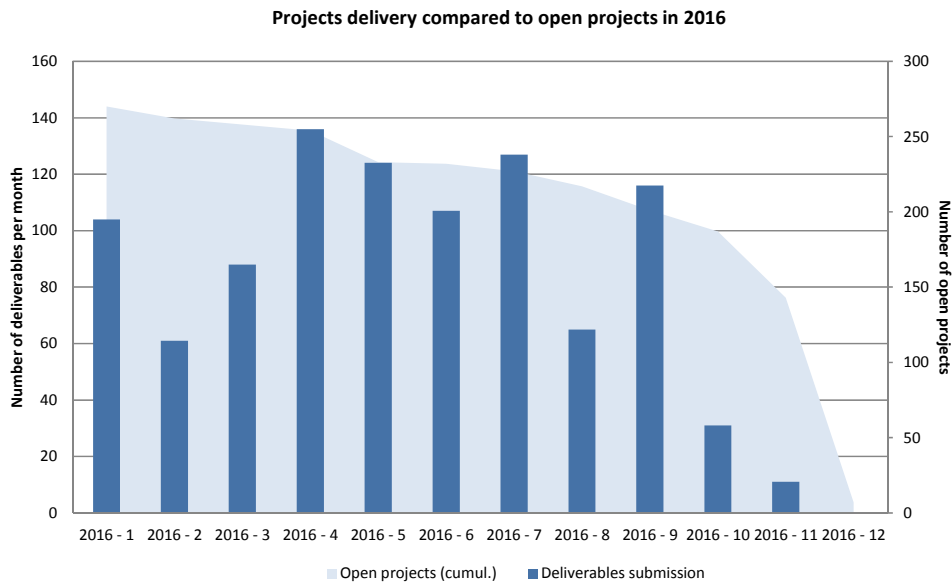


**Figure 3: Projects delivery vs. Projects closure process through 2016**

Through this important delivery in late 2015 and 2016, the SJU and its Members could "fill the gaps" in the course of 2016 compared to the overall 86% completion as at end 2015 (which is documented in the SJU Consolidated Annual Activity Report 2015). This is shown in the figure below:

**Progress of Projects in 2016 vs. 2015**
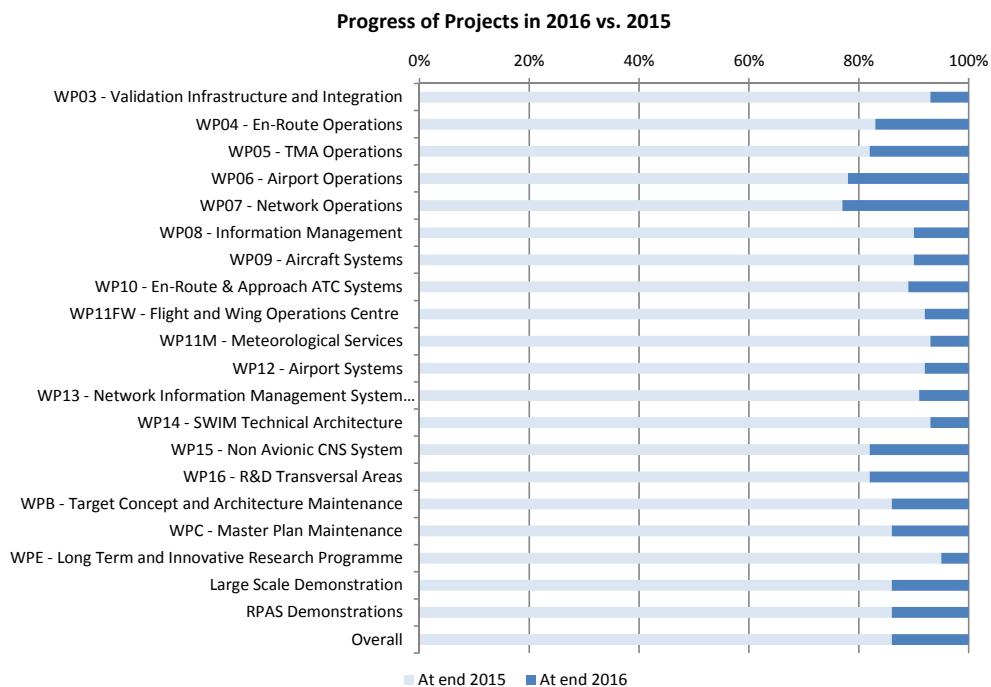


**Figure 4: Projects delivery vs. Projects closure process through 2016**

At Programme level, the 100% completion target by the end of 2016 was reached.

Founding Members

This was done thanks to the contribution of Members until the very last period of the SESAR 1 programme: considering the fact that Q4 2016 was essentially devoted to the closure of projects (cf. below), the graph below compares the cumulated effort of all SJU Members in the delivery of SESAR 1 projects during the first 3 quarters of each year. This graph shows that, despite the launch of SESAR 2020 projects in full execution (see section 1.2), the SJU was able to federate a total effort on SESAR 1 and maintain their commitment up to the end of Q3 2016:

**Cumulated Members effort in mandays per year for SESAR 1**
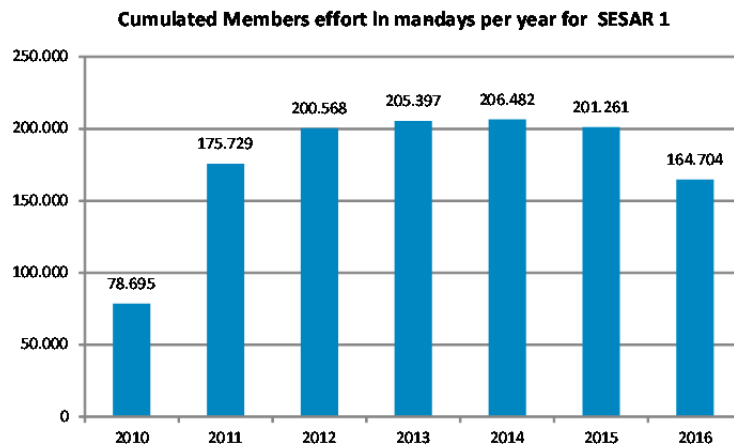


**Figure 5: Cumulated effort from SJU Members on SESAR 1 in 2016 vs. previous years**

Thanks to this intense effort, the SJU and its Members and project participants could ensure a very good quality of delivery, as is shown in the figure below, which shows that 95% of the deliverables assessed in 2016 where of good quality, while only 10 were rejected by the SJU:

**Deliverables assessment decisions in 2016**



- No reservation
- Reservation/s requiring clarification/s
- Major reservation/s
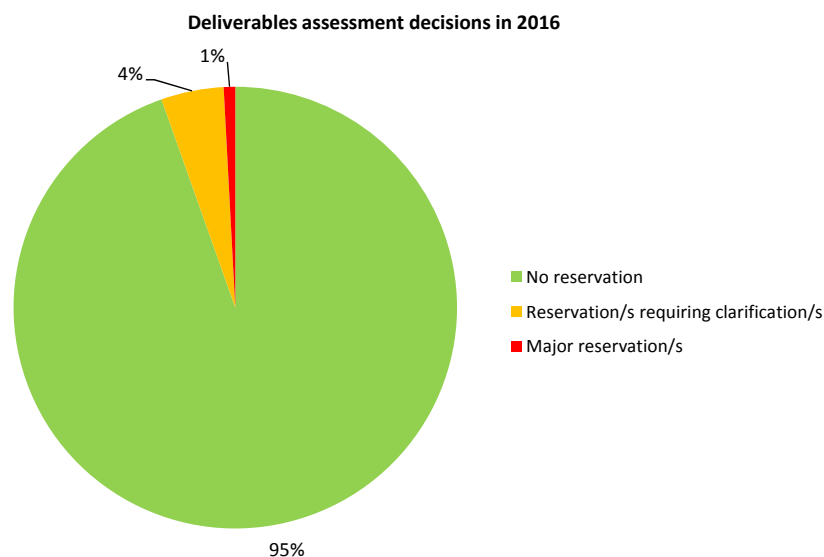
**Figure 6: Deliverables assessment outcome in 2016**

Annex I provides a more detailed update of the scope and progress of each SESAR 1 Work Package during the course of 2016.

Further conclusions on the SESAR 1 programme as a whole and it contribution to the achievement of the objectives of the SES policy, are drawn in section 1.1.2.

### 1.1.1.2 Closing SESAR 1 projects (operational part)

In addition to the delivery of the projects, the SJU proceeded with the closure of 270 projects in 2016 (2/3 of the overall programmes, all categories included), of which 194 in the sole Q4, continuing the closure activity conducted in previous years (and at a higher pace since 2015). This robust closure process was actively managed according to a plan agreed with the SJU Programme Committee which enabled to reach the key objective of 100% of SESAR 1 projects being closed from an operational standpoint at the end of 2016.



**Number of Project closures over the year 2016**
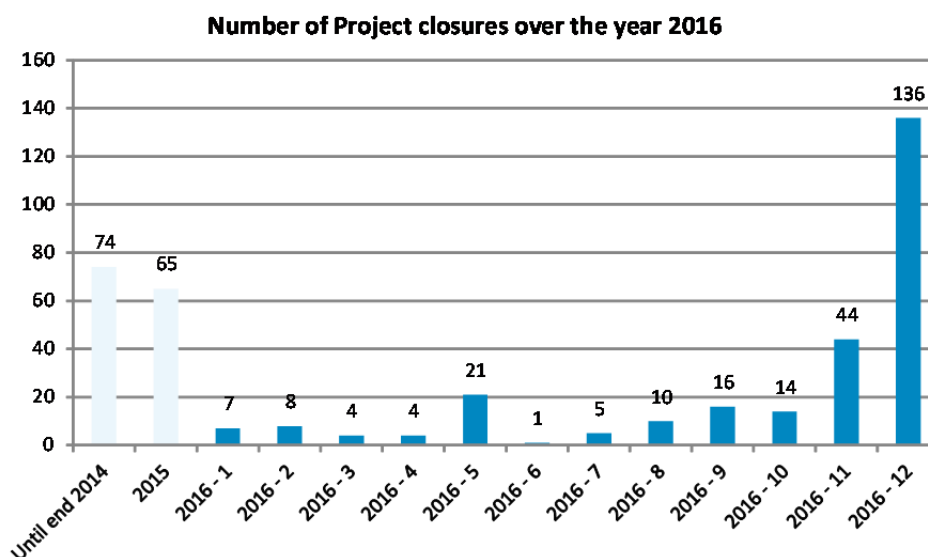
**Figure 7: Project closures through 2016**

At the end of 2016, the 390 SESAR 1 projects are formally closed from an operational standpoint, pending the processing of the final financial statements of SJU Members in 2017.

### 1.1.1.3 Programme-level activities of the SESAR 1 Programme in 2016: achieving the Release #5

As in the previous years, the SESAR ATM and Technological Solutions developed with pre-industrial level of maturity ('V3' or 'TRL6') were assessed in the context of the SESAR Release #5. Release #5 enabled to assess 30 SESAR ATM Solutions and 12 Technological Solutions, out of which

- 36 SESAR Solutions (26 ATM Solutions and 10 Technological Solutions) 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 SESAR 1. The 26 V3-mature Solutions cover the 4 Key Features of the ATM Master Plan, and 14 of them contribute to the Pilot Common Project (PCP):
  - 5 SESAR Solutions (all contributing to the PCP) have been assessed with V3 maturity in the Key Feature "Optimised ATM network services";
  - 11 SESAR Solutions (3 contributing to the PCP) have been assessed with V3 maturity in the Key Feature "High-performing airport operations";
  - 9 SESAR Solutions (2 contributing to the PCP) have been assessed with V3 maturity in the Key Feature "Advanced air traffic Services";
  - 11 SESAR Solutions (4 contributing to the PCP) have been assessed with V3 maturity in the Key Feature "Enabling Aviation Infrastructure";

- 2 Technological Solutions were assessed at maturity level 'V2' or 'TRL-4' only, meaning that they satisfy the tests in laboratory environment and are ready for transition to end-to-end environment validation,
- 4 Solutions were 'Closed for R&D', without transitioning to industrialisation, as R&D results led to the conclusion that the expected benefits cannot be brought.

The assessment of the maturity of the Solutions was done through 36 validation exercises which were run in the course of 2016 in the context of Release #5.

Further detail on the Release #5 outcome and the validation exercises for each Solution appear in annex I.1.2, which also presents each of the 36 Solutions delivered in 2016.

These achievements were regularly monitored against plan and reported into the SJU's formal governance structures, notably the Programme Committee, which provided oversight of SESAR 1.

### 1.1.2    Concluding the SESAR 1 programme 2008-2016

From 2008 to 2016, the SESAR 1 programme represents a total investment budget of EUR 2,1 billion, out of which EUR 700 million from the European ATM industry, EUR 700 million of EU funding (half under FP7, half under TEN-T) and EUR 700 million of EUROCONTROL contribution. Due to savings made over the period, additional activities were delivered compared to the original plan.

#### 1.1.2.1    What was delivered through the SESAR 1 programme?

31st December 2016 marked the successful conclusion of the first SESAR programme, with the timely closure of all 409 SESAR 1 projects, namely more than 322 industrial research projects, 45 Exploratory Research projects and 42 demonstrations.

At SESAR 1 closure date, a total of 61 mature Solutions were delivered, ready for industrialisation and deployment ('V3' or 'TRL6' as per the terminology used, cf. section 1.1.1.3). From these 61 Solutions, 36 were delivered in 2016, showing that, after a fruitful development phase, SESAR now actually offers a growing number of robust Solutions for deployment. The full list of the SESAR 1 mature Solutions is to be found in the SESAR 1 closure report (see appendix IX), classified per Key Feature and per Release: 20 Solutions address the SESAR Key Features of "High Performing airports", 21 "Advanced Air Traffic services", 8 "Optimised ATM network Management", and 12 "Enabling aviation infrastructure" (of which 6 Solutions are dedicated to the Communications, Navigation and Surveillance – CNS – domain). 23 of these 61 Solutions are included in the Pilot Common Project.

In addition to this, 54 Solutions have been initiated under SESAR 1 but will reach their V3 maturity under SESAR 2020.

The 61 Solutions delivered as mature within the SESAR 1 lifetime address all parts of the ATM value chain, from airports, air traffic services to the network, as well as the underlying systems architectures and technological enablers. They have undergone about 350 validations exercises and 30,000 flight trials, proving that they work not only on paper, but in real day-to-day operations and are operationally acceptable and beneficial to those who use them.

### 1.1.2.2 Other value-added points from the SESAR 1 programme

Additionally, the SESAR programme brings significant added value to the European ATM, consisting in:

1. **Defragmentation and collegial approach**: a robust and collegial governance model, securing wide stakeholders' buy-in, including the military, and close oversight by National and European Regulators;
2. **Solution-oriented delivery approach**: an innovation pipeline covering from exploratory research to deployment-readiness and a "factory" that generates the delivery of substantial R&I results mature for deployment and bringing measurable ATM performance gains.

**Defragmentation and collegial approach:**

One of the first and main tasks of the SJU has been to federate and pool the knowledge and resources of the entire ATM community (using membership, partnering and other cooperation mechanisms) so as to together define, develop and validate the SESAR Solutions that will modernise the ATM system. To define and develop technological solutions in close partnership is essential for three main reasons:

1. The first is to understand what is possible. Innovative ideas need to be confronted with reality checks by industry and investors, who may have different ideas and interests. Early discussion and partnership allows verifying the potential of the idea, and early identification of the possible need of evolution of business models.
2. The second critical element is to secure investors' buy-in at an early R&I stage. At the end of the day they will have to invest to implement the technological changes. Engaging them in R&I activity in the definition and development of the innovative concept is essential to convince them of the benefits that they can expect.
3. The third element is to better connect innovation with policy-making.

**Solution-oriented delivery approach**

The thorough stakeholder engagement at all stages of the programme allows a much smoother transition from R&I to deployment and much higher take-up of results than in the pre-SESAR context. 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.

After the adoption of the new edition of the European ATM Master Plan in late 2015, the subsequent update of Levels 2 (Planning & Architecture) and 3 (Implementation) was conducted. Directly derived from the European ATM Master Plan and its Key Features, the SESAR 1 programme activities are structured in three main research phases that deliver a pipeline of innovation:

1. The first phase concerns Exploratory Research, itself further categorised into those elements/projects dealing with relevant fundamental scientific subjects and those which investigate initial applications for the ATM sector;
2. The second phase includes applied research, pre-industrial development and validation projects and is delivered by the Members of the SJU. Industrial research and validation (IR) activities facilitate the migration of ideas from Exploratory Research and have them further extended in the applied research phase and finally to pre-industrial development, validation, large scale demonstration and then final preparation for deployment.

Approved

3. The third phase deals with Demonstrations, which are designed as demonstrations of particular programme concepts elements and SESAR Solutions. These demonstrations provide the bridge between the development and deployment phases of SESAR through open calls to ensure the widest possible stakeholder participation, including end-users.

The SESAR R&I programme within the SESAR project of SES is complex, far-reaching, and associating a large number of stakeholders. Still, the SESAR programme management model and governance structure allow the programme to remain performing, adaptable and even agile, so as to change orientation when needed, following the evolution of context and priorities. This model, perpetuated and reinforced under SESAR 2020 with a tighter structure and ongoing Master Planning activities governance, paves the way for future R&I in ATM and for bridging it with deployment. SESAR 2020 is designed to tackle the challenges and demonstrate that it is as agile and adaptable as SESAR 1 was. At the time of SESAR 1 closure and start of SESAR 2020, Europe is now well on its way to building the ATM system that it needs to increase the performance and sustainability of its aviation sector.

Further elements on the overall SESAR 1 programme and its benefits for the European and worldwide ATM can be found in the SESAR 1 close-out report in annex IX.3. They have been presented widely to the ATM Community during the SESAR Showcase which was organised in June 2016 (see section 1.3.3.1).

The achievements of the SESAR 1 programme pave the way for future R&I in ATM, which has started under the SESAR 2020 banner presented in the next section. Additionally, they enable the ATM community, including policy makers, to bridge towards deployment through the regular delivery of SESAR Solutions.

## 1.2   Area of Operation 2: Ramp-up of SESAR 2020

*Objective and target achievement status at the end of 2016:*

- *The Membership Accession process was completed for all 19 Members at the end of Q2, and the Agreement with EUROCONTROL was signed in September 2016*
- *All projects under IR and VLD call (with reference H2020-SESAR-2015-2) were launched in full execution at the end of Q4 2016*
- *The SESAR 2020 RPAS Exploratory Research open call (with reference H2020-SESAR-2016-1) was launched in July 2016*
- *The third SESAR 2020 Exploratory Research open call (second call of 2016 with reference H2020-SESAR-2016-6) was launched in December 2016*
- *Additionally, after the adoption of the new edition of the European ATM Master Plan in late 2015, the subsequent  update of Levels 2 (Planning & Architecture) and 3 (Implementation) was conducted*

In the course of 2016, while achieving the results presented above on the SESAR 1 programme, and concluding the open call for renewed membership of the SJU for the SESAR 2020 programme, the SJU also conducted its transition to SESAR 2020 administration and operations, successfully launching and executing projects within the framework of SESAR 2020. To that aim, the 2 calls launched in 2015 were closed in early 2016, and subsequently the grant agreements preparation could take place for

all 53 projects (28 in Exploratory Research, 20 in Industrial Research & Validation (including 3 transversal CSA projects), and 5 in Very Large-Scale Demonstrations) awarded as a result of these 2 calls. Further to the grants signature, projects were launched in full execution. At the end of 2016, all projects resulting from the 2 calls of 2015 were in full execution.

Therefore, at the end of 2016, the SESAR 2020 programme is characterised by:

- 2 calls for resulting in a total of 53 projects launched in execution:
    - ER 1 call with reference H2020-SESAR-2015-1 resulting in 28 'Exploratory Research' projects and the corresponding grant agreements,
    - IR/VLD call restricted to SJU Members with reference H2020-SESAR-2015-1 resulting in 20 Industrial Research & Validation projects and 5 Very Large-Scale Demonstration, and the corresponding grant agreements;
- Additionally, 2 calls for proposals were published under SESAR 2020 during 2016:
    - ER2-RPAS call with reference H2020-SESAR-2016-1, for a total value of EUR 9 million,
    - ER3 & VLD call reference H2020-SESAR-2016-2, for a total value of EUR 28 million.

The status of these 4 calls is presented in further detail in the following sections of this chapter, as well as the work breakdown structure of the SESAR 2020 programme as at end 2016.

Furthermore, in order to deliver and transition to normal administration and operation of activities in an H2020 environment it has been necessary for the SJU to make significant adjustments in organisational structure and ways of working. These are presented in section 1.5.

### 1.2.1    Status of the calls launched in 2015

#### 1.2.1.1    Exploratory Research call 1 (H2020-SESAR-2015-1)

The first open Exploratory Research call, H2020-SESAR-2015-1, was closed on 25 June 2015. Call provisions are summarised in the SJU's Consolidated Annual Activity Report for 2015[18].

**Call evaluation process**

A total of 128 proposals were received, 5 of which were ineligible and 123 evaluated in 2015.  The proposal evaluation process involved several phases where external experts (independent experts) were paired with SJU ATM scientific expert representatives and together they evaluated proposals received in accordance with the published procedures of H2020.

The Scientific Evaluation and Ethics Review Process was conducted according to H2020 procedures and started in July 2015.

**Call results**

Applicants were informed on 16 November 2015 and the Grant Agreement Preparation (GAP) phase started in Q3 2015 and concluded in Q2 2016 resulting in 28 projects, involving 128 participating

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[18] SESAR JU Consolidated Annual Activity Report for 2015

organisations, and of which 8 of the projects are coordinated by an SME, and for a total amount of EUR 20.4 million out of the EUR 20.6 million budget available for the call.

In 2016, after the conclusion of the GAP procedure marked by the signature of all ER1 grants, all projects were launched. 219 deliverables were received from these 28 projects in 2016 and 178 were assessed and approved. The table below provides an overview of the projects currently in execution phase, and further detail on the activity of each in 2016 can be found in the annex I.2.

The '**Work Area 1 – ATM Excellent Science & Outreach research**' contains the following projects:

| Topic Description | Projects | Max. total co-financing value (in EUR) |
| --- | --- | --- |
| Automation, Robotics and Autonomy | **AUTOPACE** proposes research on a Psychological Model to quantitatively predict how automation would impact on human performance based on cognitive resources modelling, tasks characteristics (automation) and psychological factors modelling. | 599.868 |
| | **TACO** aims to define an automated system sufficiently powerful to both accomplish complex tasks involved in the management of surface movements in a major airport and self-assess its own ability to deal with non-nominal conditions. | 599.993 |
| | **AGENT** presents traffic alert and collision avoidance system and proposes the development of an Adaptive self-Governed aerial Ecosystem by Negotiated Traffic that provides mechanisms and tools for induced collision avoidance while dynamically creating virtual Ecosystems of aircrafts as soon as a conflict is forecasted. | 598.750 |
| | **STRESS** project will address various elements HP envelope, the real-time neurophysiological indexes, the guidelines and methods to match the HP envelope status with the highest possible level of automation, the monitoring of the controllers' mental status during automation failure. | 596.875 |
| | **MINIMA** will research new human-automation interaction design concepts. | 582.780 |
| Complexity, Data Science and Information Management | **BigData4ATM** will investigate how ATM and Aviation data can be analysed and combined with more traditional demographic, economic and air transport databases to extract relevant information about passengers' behaviour and use this information to inform ATM decision making processes. | 599.733 |
| | **DART** (Data-driven AiRcraft Trajectory prediction research) explores the applicability of data science and complexity science techniques to the ATM domain. | 598.524 |
| | **MALORCA** project proposes a general, cheap and effective solution to automate re-learning, adaptation and customisation process to new environments, taking advantage of the large amount of speech data available in the ATM world. | 538.104 |
| | **BEST** will determine how semantic technologies can be used effectively to maximise the benefits of adopting SWIM. | 593.129 |

| Topic Description | Projects | Max. total co-financing value (in EUR) |
|---|---|---|
| Environment & Meteorology | **TBO-MET** project addresses the problem of analysing and quantifying the effects of meteorological uncertainty in Trajectory Based Operations. | 488.750 |
| | **ATM4E** is to explore the scope for the potential reduction of air traffic environmental impacts in European airspace on climate, air quality and noise through optimization of air traffic operations. | 599.625 |
| | **PNOWWA** project will produce methods for the probabilistic short-term forecasting of winter weather and enable the assessment of the uncertainty in the ground part of 4D trajectories. | 597.500 |
| Economics & Legal Change in ATM | **COCTA** project proposes coordinated economic measures aiming to pre-emptively reconcile air traffic demand and airspace capacity. | 534.158 |
| | **Vista** will examine the effects of conflicting market forces on European performance in ATM, through the evaluation of impact metrics on four key stakeholders and the environment. | 599.188 |
| | **COMPAIR** will investigate how to introduce competitive incentives in the ATM sector so as to best contribute to the achievement of the European high-level policy objectives for aviation. | 599.804 |

The '**Work Area 2 – ATM Applications oriented research**' contains the following projects:

| Topic Description | Projects | Max. total co-financing value (in EUR) |
|---|---|---|
| High Performing Airport Operations | **MOTO** will perform research on ATM Human Performance of using two senses: sight and hearing in the context of remote tower operations. | 999.000 |
| | **RETINA** project will investigate the potential and applicability of SV tools and Virtual/Augmented Reality display techniques for the Air Traffic Control service provision by the airport control tower. | 949.160 |
| Advanced Air Traffic Services / Separation Management and Separation Standards | **SALSA** is an exploratory research project relating to multi-source ADS-B system. | 995.064 |
| | **R-WAKE** aims at developing a simulation framework to assess the risk and hazards of potential wake vortex encounters for the en-route phase of flight. | 997.130 |
| Advanced Air Traffic Services / Trajectory Based Operations | **OptiFrame** will research a number of fundamental questions related to TBO, a key element of future ATM operating concepts. | 727.501 |
| | **COPTRA** aims to propose, in a TBO environment, an efficient method to build probabilistic traffic forecasts on the basis of flight trajectory predictions. | 999.391 |

Approved

Founding Members

EUROPEAN UNION    EUROCONTROL

| Topic Description | Projects | Max. total co-financing value (in EUR) |
|---|---|---|
| (TBO) | **PARTAKE** will propose a causal model to enhance the potential synergies that could be achieved by exploiting to the maximum extend the gap provided by the strategic decision variables and the operational decision making at flight execution. | 985.750 |
| CNS & Enabling Infrastructure | **NAVISAS** project will propose a novel concept of APNT for small aircraft that will integrate novel technologies and will merge multiple navigation avionics into one with no major impact on avionics. | 584.979 |
| | **SAPIENT** project addresses a new innovative application in the field of CNS/ATM system focusing exploitation of the synergies of Communications and Navigation technologies and the 4D trajectory management concept. | 859.500 |
| Innovative ATM Architecture, Performance & Validation | **PACAS** will model and analyse changes at different layers of the ATM system to support change management, while capturing how architectural and design choices influence the overall system. | 998.355 |
| | **INTUIT** will explore the potential of visual analytics, machine learning and systems modelling techniques to improve our understanding of the trade-offs between ATM KPAs. | 998.125 |
| | **AURORA** will propose advanced metrics to assess the operational efficiency of the ATM system. | 829.313 |
| | **APACHE** proposes a new framework to assess European ATM performance based on simulation, optimization and performance assessment tools that will be able to capture complex interdependencies between KPAs at different modelling scales. | 783.838 |

**Table 3: Exploratory Research projects selected as a result of the call H2020-SESAR-2015-1 in 2016**

### 1.2.1.2 Industrial Research and Very Large-Scale Demonstration activities WAVE1 (H2020-SESAR-2015-2)

**Call provisions summary**

As reported in SJU's Consolidated Annual Activity Report for 2015[19], the call was published in October 2015 and restricted to the candidate Members of the SJU. This call was designed to meet the requirements of the 2015 ATM Master Plan's Key Features as reflected within the SESAR multi-annual work programme (MAWP) adopted by SJU's Administrative Board in July 2015. The MAWP itself is split in two waves: Wave 1 (2016 to 2019) and Wave 2 (2019 to 2021), with this call for Proposals covering Wave 1 projects only.

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[19] SESAR JU Consolidated Annual Activity Report for 2015

The activities of this call, referring to Wave 1 only, were organised into three separate Work Areas (SESAR 2020 Transversal Activities, Industrial Research and Validation and Very Large Scale Demonstration Activities) and broken down into 28 topics:

- Work Area A – SESAR 2020 Transversal Activities: 3 topics,
- Work Area B – Industrial Research & Validation Activities: 18 topics,
- Work Area C – Very Large Scale Demonstrations Activities: 7 topics.

The total budget allocated for this call was EUR 260 million (EUR 218 million for IR comprising Work Areas A and B, and EUR 42 million for VLD comprising Work Area C).

**Call results**

28 proposals were received, and evaluated during Q2 2016 by SJU expert and programme management staff and for all topics they were supported and scrutinised by at least one independent expert. Applicants were informed on 8 July 2016 of the results of the award procedure: 25 proposals were retained and the Grant Agreement Preparation started immediately after and concluded with the signature of grants from 30 September to 1 December 2016. The total amount of maximum co-financing resulting from the Grant Agreement Preparation is EUR 246,5 million (EUR 208,8 million for the 20 IR projects and EUR 37,7 million for the 5 VLD activities; the detailed breakdown is provided in the following tables). Pre-financings for all 25 grant agreements have also been paid in Q4 2016. Consequently, all IR and VLD projects were launched in execution in Q3 and Q4 2016. The list of projects and the related maximum co-financing value resulting from the call IR-VLD Wave 1 (H2020-SESAR-2015-2) are the following:

**Work Area A – SESAR 2020 Transversal Activities:**

| Ref. | Project title | Short Topic/Project Description | Type of Action | Max. total co-financing value (in EUR) |
|---|---|---|---|---|
| PJ.19 | Content Integration | "Content Integration" (CI) activities will aim to coordinate and integrate operational and technical solutions, and as such to support and guide the processes to ensure their completeness, consistency and coherency from a holistic perspective as expressed in the SESAR CONOPS. | CSA | 7.395.142 |
| PJ.20 | Master Plan Maintenance | The ATM-MP has three levels (Executive, Planning and Implementation) that require synchronised monitoring and alignment. The work shall consist in maintaining, updating and publishing as and when necessary the ATM-MP. It shall also consist in managing the ATM-MP update campaigns. | CSA | 3.327.676 |
| PJ.22 | Validation & Demonstration Engineering | Development of the Validation & Verification Infrastructures (V&VI) and Platforms (V&VP) development required for supporting SESAR Validation Exercises. | CSA | 2.051.356 |

**Work Area B – Industrial Research & Validation Activities:**

## Optimised ATM network services

| Ref. | Project title | Short Topic Description | Type of Action | Max. total co-financing value (in EUR) |
|------|---------------|------------------------|----------------|----------------------------------------|
| PJ.07 | Optimised Airspace Users Operations | Evolving ATM environment through SESAR towards a Trajectory Based environment in order to improve Airports and ATM Network performance | RIA | 2.247.336 |
| PJ.08 | Advanced Airspace Management | Address the definition and refinement of relevant interfaces between Advanced Airspace Management and other processes such as DCB, FRA, NOP, flight planning. | RIA | 2.738.349 |
| PJ.09 | Advanced Demand Capacity Balancing (DCB) | Provide building blocks to complement Network Management with Network Intelligence based on shared situation awareness, a common set of values and rules and highly interconnected local network management functions. | RIA | 7.153.347 |

## High-performing airport operations

| Ref. | Project title | Short Topic Description | Type of Action | Max. total co-financing value (in EUR) |
|------|---------------|------------------------|----------------|----------------------------------------|
| PJ.02 | Increased Runway & Airport Throughput | Enabling enhanced runway throughput to improve efficiency and resilience of arrival and departure operations. | RIA | 15.592.783 |
| PJ.3a | Integrated Surface Management | Further integration of ATC tools through Surface Management with other systems to enhance abilities to deliver, plan and improve the use of airport resource allocation. | RIA | 12.925.436 |
| PJ.3b | Airport Safety Nets | Addressing further improvements in SESAR 2020 to reduce the number of runway incursions prevent collisions on the apron and taxiway with traffic and fixed obstacles. | RIA | 8.228.382 |
| PJ.04 | Total Airport Management | Development of performance-based ATM system as the cornerstone of future airport concept, foreseeing an integrated airport management framework. | RIA | 8.909.055 |

| Ref. | Project title | Short Topic Description | Type of Action | Max. total co-financing value (in EUR) |
|---|---|---|---|---|
| PJ.05 | Remote Tower for Multiple Airports | Validation of concept that effective provision of ATS to multiple remote sites is possible, and is at least as safe as current methods of service provision. | RIA | 9.013.121 |

## Advanced air traffic services

| Ref. | Project title | Short Topic Description | Type of Action | Max. total co-financing value (in EUR) |
|---|---|---|---|---|
| PJ.01 | Enhanced Arrivals and Departures | Addresses interaction between Traffic Synchronisation and DCB within the extended horizon. Potential information integration needs and balancing mechanisms to be investigated and developed. | RIA | 17.521.324 |
| PJ.06 | Trajectory Based Free Routing | Realising the objective of airspace users to plan flight trajectories without reference to a fixed route network or published directs within high & very high-complexity environments. | RIA | 6.029.408 |
| PJ.10 | Separation Management En-route & TMA | Looks at the tactical layer of separation management (for resolution advisory purposes demand and capacity balancing considerations will be taken into account if feasible, but main objective is aiming at the provision of separation between aircraft). | RIA | 26.388.516 |
| PJ.11 | Enhanced Air & Ground Safety Nets | Current Airborne Collision Avoidance System (ACAS) performance requirements will need to be adapted for the future operations identified by the SESAR Concept. This topic looks at the adaptation of ACAS to new separation modes and to new categories of airspace users. | RIA | 5.478.830 |

## Enabling aviation infrastructure

| Ref. | Project title | Short Topic Description | Type of Action | Max. total co-financing value (in EUR) |
|---|---|---|---|---|
| PJ.14 | Communications, Navigation and Surveillance (CNS) | Enforce new CNS technical capabilities to meet operational requirements and needs, taking into account the newly emerging CNS technologies. GA/R and Remotely Piloted Aircraft Systems (RPAS) needs will also be integrated within CNS solutions development. | RIA | 23.213.533 |
| PJ.15 | Common Services | This topic will develop solutions that are expected to enhance the benefit of operational solutions, especially their cost effectiveness, by identifying opportunities to provide them through alternative organisational arrangements. This is achieved through the discovery, definition and validation of common services and their enabling elements in the operational solutions. | RIA | 5.784.514 |
| PJ.16 | CWP – HMI | Looking at automation and new tools to assist Airport ATS, TMA and En-Route Controllers. | RIA | 12.861.754 |
| PJ.17 | SWIM Infrastructures | Further mature and validate SWIM A/G solutions for advisory services and for safety critical services, federated identity management, a common runtime registry & civil-military interoperability. | RIA | 9.754.599 |
| PJ.18 | 4D Trajectory Management | Sharing trajectories between ATM actors including Airspace Users through an iterative process to take into account more accurate data once available (e.g. intentions, MET forecast, current traffic, airspace management). | RIA | 22.193.941 |

**Table 4: IR Projects resulting from Wave 1 call H2020-SESAR-2015-2 and their max. co-financing value**

**Work Area C – Very Large Scale Demonstrations Activities:**

| Key Feature | Ref. | VLD activity title | Short VLD activity description | Max. total co-financing value (in EUR) |
|---|---|---|---|---|
| Optimised ATM [L] network services | PJ.24 | Network Collaborative Management | Demonstrations that improve the European ATM network performance, notably capacity and flight efficiency through exchange, modification and management of trajectory information | 4.759.842 |
| High-performing airport operations | PJ.28 | Integrated Airport Operations (incl. TBS) | Demonstrations focussed on functionalities that enhance airport Integration and throughput | 4.001.142 |
| Advanced air traffic services | PJ.25 | Arrival Management extended to en-route Airspace | Demonstrations showing extended Arrival Management to en-route Airspace (AMAN horizon extended from 100-120 nautical miles to 180-200 nautical miles from the arrival airport) | 3.914.104 |
| Enabling aviation infrastructure | PJ.27 | Flight Information Exchange | Demonstrate Flight information exchange during the pre-tactical and tactical phases by ATC systems and Network Manager | 6.079.367 |
|  | PJ.31 | Initial Trajectory Information Sharing | Demonstrate initial Trajectory Information Sharing (i4D) consisting of the improved use of target times and trajectory information, including where available the use of on-board 4D trajectory data by the ground ATC system & Network Manager Systems | 18.955.106 |

**Table 5: VLD activities resulting from Wave 1 call H2020-SESAR-2015-2 and their max. co-financing value**

[20] Projects PJ.23 'Flexible Airspace Management and Free Route' and PJ.26 'Enhanced Terminal Airspace using RNP-Based Operations', which were foreseen in the H2020-SESAR-2015-2 call conditions, were not awarded and are therefore not part of the 5 VLD activities

Further detail on these projects and activities is provided in annex I.2.

### 1.2.2    Work breakdown structure of the SESAR 2020 programme at end 2016

As a result of the calls launched in 2015 and concluded in 2016 (see section 1.2.1), the SESAR 2020 programme counts 53 projects organised in the following work breakdown structure:
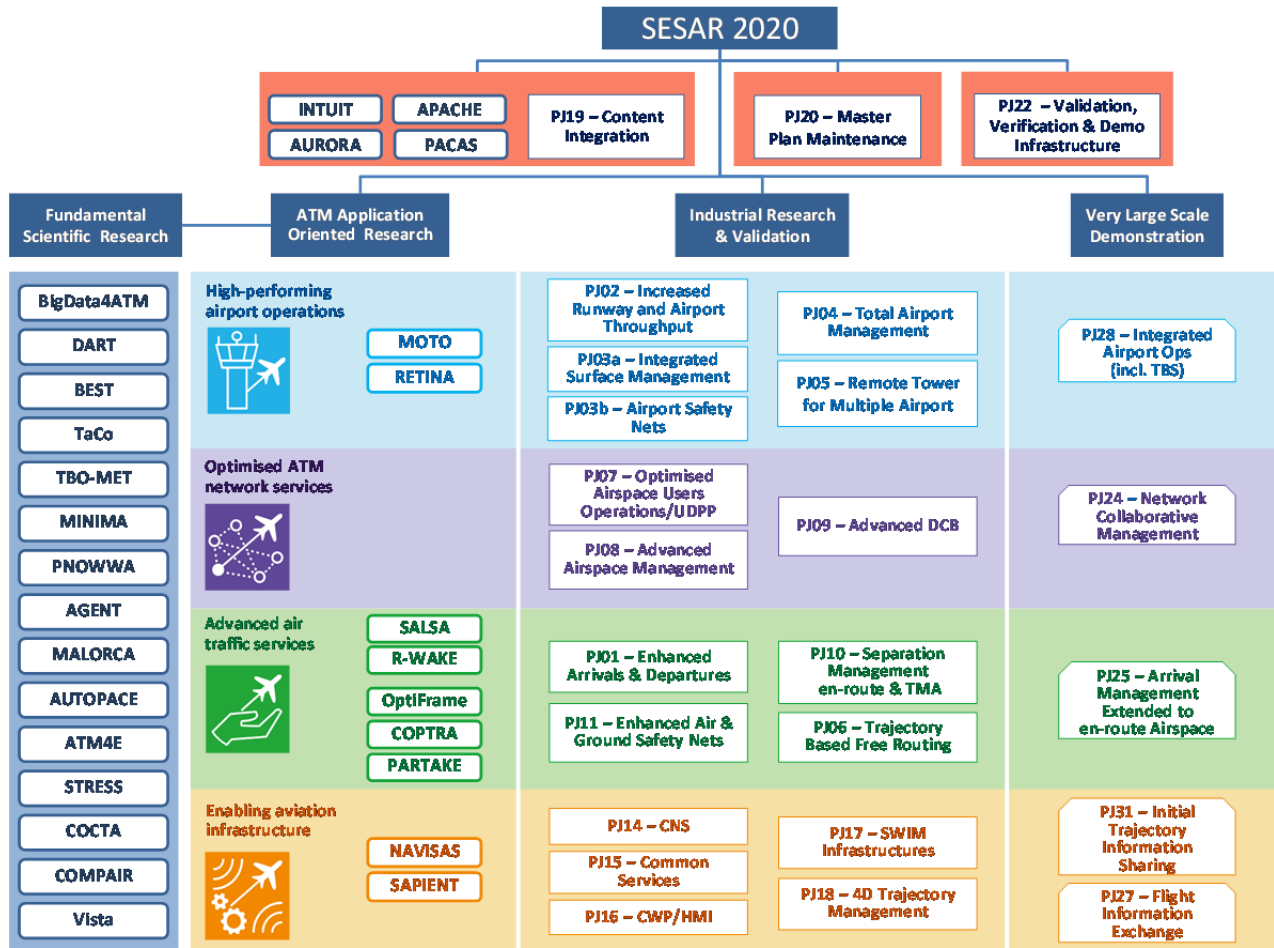


**Figure 7: Work breakdown structure of the SESAR 2020 programme at end 2016**

### 1.2.3    New calls launched in 2016

In addition to the activity conducted to follow on the 2 calls publication in 2015, the SJU prepared and organised the launch of two additional open calls, as per the Annual Work Programme for 2016:

- The second Exploratory Research call, ER2 focusing on RPAS, with call reference H2020-SESAR-2016-1;
- The third Exploratory Research call, coupled with the first Open VLD call, with reference H2020-SESAR-2016-2.

These 2 calls are presented in the following paragraphs.

### 1.2.3.1    Exploratory Research 2 on RPAS (H2020-SESAR-2016-1)

A second open call dedicated to Exploratory Research was launched in Q3 2016 with the objective to seek to address unresolved problems across the ATM Research domain and to transfer the results of past research and apply them to new applications and/or novel technologies in search of innovative and ground-breaking results. Following on from the first set of projects launched as a result of the first call in March 2015 a second call under the frame of the SESAR 2020 Exploratory Research Programme was organised to focus on the priority topic of Drones and RPAS integration.

The scope and topics included within the call were developed by the SJU drones and RPAS experts, based on a review of the current state of the art in developments such as JARUS, the US UTM initiative and the standards developments in EUROCAE (WG-73 and WG-93), and in coordination with the European Commission and EASA to address the new challenges of drones and RPAS.

The following 7 topics, divided in two Work areas, were included in the call:

**Work Area 1:**

- RPAS-01: SESAR UTM Concept Definition: The operation of potentially large numbers of drones at low levels, mostly outside airspace where there is any formal ATC, presents a number of significant operational challenges. For this reason, it is necessary to establish a clear concept of operations that is understood and agreed by all stakeholders. The research will include identification of how drones can be operated safely in non-nominal situations, without posing an unacceptable danger to other airspace users, or people and property on the ground. This project will also examine non-aviation aspects of drone operations, to identify key issues for society and to offer solutions to ease social acceptance

**Work Area 2:**

- RPAS-02: Drone information management: In manned aviation, the sharing of timely and relevant information, of guaranteed quality, is recognised as a prerequisite for safe and efficient operations. Drones will operate in complex low-level airspace where there will be other drones, manned aircraft, buildings and terrain hazards. It is essential, therefore, that aeronautical information and planning facilities are sufficiently robust and accurate to enable these operations to be conducted safely and efficiently.
- RPAS-03: Aircraft systems: VLL drones represent a new type of air vehicle that operate in a fundamentally different way to conventional aviation. In order to remain safe and effective, they will require new technologies to be developed and installed on the air vehicle itself, or for existing technologies to be used in a different way, both of which should be safely interoperable with existing manned aviation.
- RPAS-04: Ground-based technology: The operation of drones in VLL airspace introduces new challenges not encountered by manned aviation. Typically, outside the vicinity of airfields, there is limited infrastructure to support aerial operations, such as communication and surveillance. It is necessary, therefore, to examine the concept of operations for VLL drone operations and to specify the ground-based technologies that are required to enable that concept.
- RPAS-05: Datalink: Most drones, even autonomous ones, will need some form of data link. This could be for command and control, payload, collision avoidance, communication with the UTM system etc. Many technologies exist for data link from within and without the aviation world and it is necessary to identify which technologies are suitable for use to enable safe and efficient drone operations. Given the potential volume of drones that may

be operating, it is critical to understand the ability of scarce spectrum resources to support such datalink requirements, and to ensure that drone operations using these technologies do not adversely interfere with manned aviation.

- RPAS-06: Security & cyber-resilience: The operation of drones represents a new challenge to society in that, for the first time, airborne assets will be available to anyone to fly, yet which have the capability to invade privacy or to cause distress and damage to people and property. It is essential, therefore, to ensure that the risk to the public is minimised by effective regulation, supported by appropriate technologies.
- RPAS-07: Science for higher levels of automation: It is expected that, by 2035 the rise of commercial & civil drone usage would lead to a much denser form of air traffic at VLL, with many more interactions between air traffic participants. This poses a considerable challenge from a traffic management point of view. The challenge is to find a robust and interoperable technical solution that is suitable for the smallest of drones. Importantly, many of these drones are envisaged to operate autonomously.

The aim of this procedure was to award up to 10 Grant Agreements (GAs), including 1 GA for Work Area 1. The types of actions to be awarded are limited to Research and Innovation actions for all topics.

The budget available for the call was EUR 9.000.000 with a planned distribution across Work Area 1 of around EUR 800.000 and for Work Area 2 of around EUR 8.200.000.

The called opened on 14 July 2016 and closed on 15 November and 59 proposals were submitted, of which one was withdrawn and two were considered ineligible. The remote evaluations took place in December 2016 and the central ones were planned for January 2017. The grants awarded in that context will deliver their results in the period 2018-2019.

### 1.2.3.2   Exploratory Research 3 and Very Large-Scale Demonstrations call (H2020-SESAR-2016-2)

A third open call was launched on 15 December 2016 and it is planned to close on 11 May 2017. It consists of two different Work Areas: 'Exploratory Research' covering 6 topics and 'Very Large Scale Demonstrations' covering a further 10 topics. The total budget of this call is EUR 28.000.000, divided in EUR 10.000.000 for Exploratory Research and EUR 18.000.000 for Very Large-Scale Demonstrations.

**Work Area 'Exploratory Research'**

The first Work area, Exploratory Research (ER), drives the development and evaluation of innovative or unconventional ideas, concepts, methods and technologies that can define and deliver the performance required for the next generation of European ATM system. In this Work Area, there are six topics to be covered under two sub-Work Areas: transversal exploratory research activities (WA1.1) and a further set of ATM application-oriented research (WA1.2) which builds on and complements the research topics already included in the first call for exploratory research in 2015. It includes Research and Innovation actions and a Coordinated and support action.

The sub work area WA1.1. "Transversal Exploratory Research" consists of one support topic that shall establish an overarching view across ATM exploratory research, providing a coordinated exchange of research knowledge across a wide range of relevant themes, and within the context of this networking, help to further stimulate the Future ATM Skilled work-force for ATM, including the coordination and funding of relevant PhD projects. The SJU is aiming to award one project in this sub work area with a maximum duration of 4 years.

The sub work area WA1.2 "ATM application-oriented research" will help mature new concepts for ATM beyond those identified in the ATM Master Plan as well as help mature emerging technologies and methods to the level of maturity required to feed the applied research conducted in the Industrial Research and Validation phase of SESAR; thus connecting the ATM Exploratory Research to the ATM Applied Research in the context of the European ATM Master Plan. The topics in this sub work area WA1.2 are:

- Advanced Air Traffic Services – Current separation minima are for the most part defined to be dependent on the reliability and accuracy of the position information displayed to the controller. In some cases reduced minima have been defined for flights guided by specific navigation equipment, as is the case for aircraft on parallel Instrument Landing System (ILS) localizers, based on the fact that the knowledge that the aircraft is on the localizer reduces both the uncertainty of the present position and how its future position may evolve. This topic will address the extension of this concept, proposing new separation minima when non-surveillance information on the aircraft position is available, for example for aircraft flying on PBN routes, flights having downlinked their FMS-predicted trajectory, or flights having agreed to comply with specific ATM constraints.
- Optimised ATM Network Services – The sharing and management of trajectory information provides consistent information which allows the use of each flight's agreed trajectory as a unique, common reference for decision-making. Today Europe's Network Manager (NM) carries out regional coordination of Demand and Capacity Balancing (DCB) in a centralised architectural approach. This topic will address the application of Trajectory Based Operations in support of DCB functions, independent to any specific system architecture allowing the extension of such functions to a global context leading to a consistent and coherent trajectory management approach within and between regions.
- Enabling Aviation Infrastructure - This topic addresses how lightweight and/or low-cost devices suitable for airspace users such a General Aviation, could be allowed to operate safely and effectively alongside full-specification devices without compromising safety or adversely impacting the aviation spectrum environment. The topic will address how technology for voice and data link communications, PBN, surveillance, and collision-avoidance, could be regulated and approved by aviation authorities without having to undergo the rigorous and costly certification processes associated with existing full-specification devices.
- Enabling Aviation Infrastructure - The use, or adaptation, of new technologies being developed outside ATM to support ATM Communication, navigation and surveillance (CNS) needs will be considered including analysis of the safety, performance and security implications for the ATM system. More flexible system architectures for ground and airborne systems will be considered in this context (e.g. building on integrated modular avionics and an open interface approach to ground system development) to help unlock us from legacy technologies.
- ATM Operations, Architecture, Performance and Validation - This topic will address activities on ATM system design and architecture using novel methods to analyse and propose evolutionary approaches aimed at guaranteeing its robust transition towards the future. This includes the needs and challenges in developing a harmonised technical infrastructure for ANS, including its operational and economic impacts. The potential of architecture in providing suitable means of assurance for validation or evidence to support decision-making and strategic thinking.

The SJU is looking to further award around 8-12 projects, under this sub work area with an indicative duration of 2 years.

**Work Area 'Very Large Scale Demonstrations'**

As regards the second work area of this call, Very large demonstrations (VLD), the objective is to bridge "industrial research" and "deployment". All VLDs shall aim, as a minimum, at including a demonstration in a close-to-operational environment along with the preparation for platform availability to support demonstrations in targeted operational environments that engages relevant end-users and stakeholders. In includes Innovation and support actions.

This Work Area addresses 10 topics across three sub Work Areas; these complement the SJU Members Wave 1 VLD activities, launched through the H2020-SESAR-2015-2 call, where additional activities are sought that will ensure successful very large-scale demonstrations (VLDs).

The sub Work Area "WA2.1 SESAR Solutions for High Performing Aviation in Europe" is aiming at securing the involvement of additional end-users to perform operational demonstrations to confirm the benefits and increase awareness of promising solutions targeting specific operational scenarios and operating environments. The scope is structured into separate topics that are all geared at securing the involvement of additional end-users to perform operational demonstrations to confirm the performance of SESAR Solutions and raise awareness.

The SJU is looking to award around 10-15 projects, with an indicative duration of 2 years, across the following six topics:

- Arrival Management Extended to En-Route Airspace - The Arrival Management (AMAN) extended to en-route extends the AMAN horizon from 100-120 NM to 180-200 NM from the arrival airport, allowing traffic sequencing to be conducted in the en-route and early descent phases. The arrival constraint generated by the extended AMAN takes into account the different flows of arrival flights delivered by different neighbouring ACCs and this information is passed to two or more upstream ACCs.
- Integrated Airport Operations - addressing efficient provision of approach and aerodrome control services through improved both runway safety and throughput and optimised surface operations. This encompasses advanced departure management procedures and tools, enhanced surface management including planning and routing, and the use of ground safety nets to monitor routing conformance, detect conflicting clearances and deliver alerts to the controller.
- Network collaborative Management – addressing cooperative traffic management environment based on the exchange, modification, and management of trajectory information in both pre-departure and execution phases of the flight in order to improve the European Network performance, particularly capacity and flight efficiency. It consists in optimising the delivery of traffic in sectors and airports while assessing accurately the capacity needs corresponding to the traffic demand. It includes an enhanced evaluation of the demand through identification of hotspots and assessment the traffic complexity and the proposal of appropriate ATFCM solutions which integrate multiple local dynamic capacity balancing (DCB) constraints.
- Initial Trajectory Information Sharing - The trajectory will become the standard for ATM and requires to be regularly updated and shared among involved stakeholders including ANSPs/ACCs and network management. This is a first step which is expected to bring already significant improvement in flight efficiency and particularly predictability. It consists in

equipping an adequate number of mainline aircraft and assessing technical and operational impact of downlinking trajectory information contained in the FMS during commercial flights.

- Efficient services and infrastructure delivery - addressing common support function which would allow temporary provision of some services or information such as Flight plan or radar information in order to ensure continuity in the delivery of efficient ATS services in case of major technical failure at one of the ACCs.
- Increased access to airports for low visibility mixed fleet operations – A great number of European airports are not equipped with advanced ground infrastructure that allows Cat II/III procedures in bad weather conditions and especially in low visibility conditions (particularly true but not limited to medium and small size airports). This topic addresses the use of advanced on-board equipment as well as GNSS (such as EGNOS) to support safe airport access for mixed fleet operations including Business Aviation as well as Mainline.

The sub Work Area WA2.2 Global Interoperability is structured into two topics that both recognise that aviation is a global industry and interoperability together with global harmonisation are key for its safe and sustained growth. The activities under this work area shall address global interoperability demonstrations targeting operational changes that are considered to be on the critical path for ATM modernisation.

The SJU has put in place Memoranda of Cooperation (MoC) under the EU bilateral agreements and relations with non-EU States. These MoC´s provide the international context and frame for the activities to be conducted under this work area, in particular with regards to link the International Civil Aviation Organisation's (ICAO), Global Air Navigation Plan, GANP/ASBU´s development and implementation efforts.

The SJU is looking to award around 2-4 projects, with an indicative duration of 2 years, across the following two topics:

- Applications for trajectory based flow and queue management using EPP extended into Oceanic/Inter-continental operations – addresses the use of aircraft derived EPP information in a simulated and/or live environment to improve operational applications for ATS/ATC-traffic synchronisation and ATFM purposes with a specific emphasis on global interoperability. It may also include demonstrations on technical feasibility and benefits of using satellite communications during the entire flight to exchange trajectory information.
- Applications for improved flight trajectories using SWIM B2B services – building on the results achieved in previous SWIM global demonstration activities, this topic addresses the use of specific SWIM services for improved flight planning, flight briefing and flight following through global interoperability. This encompasses in particular pre-departure flight plan information that could be exchanged in an agreed standard but also other kind of B2B services relevant during the execution of the flight.

The sub Work Area WA2.3 Safe Integration of all Air Vehicles is structured into two topics that focus on Safe Integration of all air Vehicles. The activities to be performed are geared at demonstrating solutions which support interoperability and allow the integration of all airspace users (including general aviation, rotorcraft and drone operators) in an efficient and non-discriminatory manner, whilst also ensuring safety.

The SJU is looking to award around 7-10 projects, with an indicative duration of 2 years, across the following two topics:

- Solutions for General Aviation and Rotorcraft – addresses specific solutions linked to SESAR concepts using non certified on-board equipment and shall demonstrate the benefits of such solutions regarding the improvement of situation awareness and safety. Although demonstrations are expected to occur in class G airspace, they should be geared to the possible extent, at building confidence for safe integration of GA and rotorcraft operations in all classes of airspace.
- Safe integration of drones – Safe integration of drones in the airspace has to be considered in the relevant context according to mission type, altitude, class of airspace and type of drone. This topic addresses demonstrations to build confidence on solutions that would support the safe integration of drones in all classes of airspace (including Very Low Level Operations) and that could be deployed at a larger scale within the next 5-8 years. Particular focus should be put on solutions enabling the following mission types: long range surveying (primarily BVLOS), light load movement (primarily BVLOS) and long endurance surveying (primarily at altitudes above 150 metres). In addition the aim will be ultimately to subsequently extend such functionalities towards Dynamic Airspace Management which is to be backed by a robust geo-fencing capability and work contributing to the development of this capability is within scope of this call.

## 1.3   Area of Operation 3: Effective stakeholder engagement by the SJU

*Objective and target achievement status at the end of 2016: the main working and collaboration arrangements with third-party stakeholders (EASA, EDA, ESA, ACI, Clean Sky, Civil Airspace Users, Professional Staff Associations, National Authorities…) were set up at the end of Q4, and the collaboration with NextGen and the SESAR Deployment Manager was effective as from the beginning of 2016*

*Furthermore, the SESAR JU has published its first edition of the SESAR Solutions Catalogue, and has organised the SESAR Showcase*

A critical element of the mandate of the SJU is to ensure the involvement of all stakeholders of the European ATM and of international aviation. To this end, the SESAR JU develops engagement frameworks at both the European and the international levels, and communication activities towards a variety of stakeholders.

This section describes the activities conducted in 2016 in this context.

### 1.3.1   External Affairs

A fundamental principle of the SJU is to broaden and deepen collaboration with a range of different stakeholders in order to benefit from their expertise and gain their assurance that SESAR Solutions meet the needs of the entire European ATM and aviation community (the fact that such stakeholders contribute to projects and validation activities secures to a large extent the operational inputs

necessary and is in line with the users' expectations on the delivery of SESAR solutions). As such, third-party participation and active input into SESAR projects continued during 2016.

In 2016, the cooperative arrangements with external stakeholders were renewed as a consequence of the closing of SESAR 1 and the ramp-up of SESAR 2020 to fit with the financial rules and the rules of H2020. Updates to the arrangements were mostly scheduled over second half of 2016 not to interfere with the activities in relation to the closing down of projects in SESAR 1. All were concluded, the last ones coming into place quarter 1 2017. Support in SESAR 1 was well developed under the third-party management tool of the SJU for coordinated input of expertise to relevant projects which turned out beneficial to the projects results. Third-parties also played a major part in the June 2016 SESAR Showcase event in Amsterdam giving evidence and support to the dissemination of SESAR 1 outcome. The SJU also saw also a greater interest and thereby good coordination and inputs in key areas towards interoperability and harmonisation internationally and towards ICAO.

### 1.3.1.1 The SESAR Deployment Manager (SDM)

During 2016, the collaboration under the 2015 MoU between the SJU and SDM continued on a day-to-day level as well as in two Steering Committee meetings where the cooperative work was reviewed, discussed and given a steering on key topics. The cooperative arrangement covers the full ATM modernisation range of topics and is described in annexes to the MoU. The SJU and SDM respective focal points work out common SDM/SJU reports. Of particular interest during 2016 were the coordination between the Deployment Programme and the SESAR 2020 programme, the Master Plan and Deployment Programme in particular around Master Plan Level 3 reporting, the international coordination specifically with the U.S. NextGen programme and lastly in building up a common strategy communications for events and publication, specifically for events like the World ATM Congress 2017.

The SJU and SDM establishing a common approach to align under the SESAR programme as one whilst respecting their different rules and governance mechanisms, was a major achievement which started to pay off in increase of coordination by setting up bi-monthly meetings to iron out any particular areas of concern early and to create good relationships between the complete SESAR teams. Aligning and bridging between development and deployment allows sharing experiences from both sides to support the work in order to safeguard the interoperability standards provisions of SESAR solutions. The continuous push for driving SESAR ATM modernisation to represent and connect the full R&I life cycle from definition, securing the bridging between innovative research through industrial developments and validations/demonstrations (SESAR 2020) all the way to and including preparation for deployment of SESAR Solutions build the platform for cooperation and coordination.

The MoU EU and the U.S. on NextGen – SESAR interoperability has been enhanced in terms of participation, resulting in the complete SESAR JU and DM expertise being available and involved where necessary in common activities relating to the definition (Master Plan), development (SESAR 2020) and Deployments (Deployment Programme. Certain areas like on A/G Data communications have seen the full SESAR teams being involved in developing strategies and roadmaps for covering the short/medium/long term planning.

In the domain of interoperability and standards, the cooperation has further strengthened the links with Standard Making Organisations like EUROCAE, RTCA etc. to support standardisation with SESAR material and by doing so ensuring alignment of priorities in relation to SESAR 2020, the ATM Master Plan, industry standards developments and the evolution of ICAO provisions.

### 1.3.1.2    The European Aviation Safety Agency (EASA)

EASA and SJU have signed a new Memorandum of Cooperation for SESAR 2020 on 23 November 2016. The core areas of cooperation are the following:

- Regulatory coordination and identifying the regulatory needs to prepare for the harmonised deployment of SESAR Solutions;
- Coordination of research in the areas of aviation safety, environment, and interoperability;
- Coordination of international cooperation with key third countries such as USA and China, supporting ICAO activities on the Global Air Navigation Plan (GANP) and Global Aviation Safety Plan (GASP), and providing support for international technical cooperation; and
- Technical advice in the areas of CNS (communication, navigation, and surveillance) technologies, drones, avionics and air to ground interoperability.

### 1.3.1.3    EUROCAE

The SJU contributed to ensuring ongoing alignment between SESAR work and standards proposal developments and the EUROCAE working arrangements and planning through its active participation in the EUROCAE Council and Technical Advisory Committee. This included specifically drafting parts of the EUROCAE Technical Work Programme to ensure alignments with SESAR planning and needs. The SJU also gave a keynote speech at the EUROCAE General Assembly and Symposium in April 2016.

During 2016, SESAR deliverables were made available in support of standardisation development work in 5 EUROCAE Working Groups covering SWIM, Surveillance systems, Remote Tower and GBAS.

EUROCAE published 6 standards in 2016 with contributions from and of direct relevance to SESAR solutions including datalink applications.

### 1.3.1.4    The European Air Traffic Management Standards Coordination Group (EASCG)

In 2016 the SJU continued as an active participant in the European Air Traffic Management Standards Coordination Group (EASCG), with the objective to coordinate standardisation activities, identify their links with the R&D activities and to provide a forum for discussion. The SESAR standardisation roadmap activity under the frame of WP C was used as a direct input into this group. The ongoing result of this activity is reflected in the 2nd edition of the European ATM Standardisation Rolling Development Plan, and provides not only the reference for ATM standardisation needs in European (including SESAR specific needs) but also serves as the basis for the European input into the ICAO standardisation roadmap development.

### 1.3.1.5    National Supervisory Authorities

The successful outcomes of SESAR are reliant on the involvement of the full spectrum of stakeholders, including National Supervisory Authorities, throughout the value chain. In this respect, the SJU proposed, at the end of 2016, to update Memorandum of Cooperation to those Authorities who already had MoC with SJU and invite those Authorities in SES area who would like to join SESAR 2020 cooperation platform to sign new MoC with SJU.

In response, 16 National Supervisory Authorities are willing to contribute towards successful execution of SESAR 2020 programme and the SESAR JU already signed agreements with these 16 organisations. The core areas of cooperation are the following:

- Impact of the new concepts on the rulemaking, oversight and certification activities of the Authority in its different fields of competency including safety, security (particularly cyber-security), economic, environmental and airspace management;
- Impact of changes in the ATM Master Plan on the authority activity;
- Assist and where applicable to participate in coordination of approval process for Very Large Scale demonstration activities;
- Assist in areas of specific domain as: drones, cyber-security performance aspects of the SESAR 2020.

### 1.3.1.6 Military and State Aviation

In Europe, military aviation represents hundreds of military areas and dozens of military airfields. An estimated 30% of military flights fly according to the rules of General Aircraft Traffic (GAT), while the remaining operates as Operational Air Traffic (OAT). Sovereign military undertake a wide variety of missions for training purposes, homeland security (incl. sovereignty missions), as well as cross-border crisis management operations. For such missions, access to airspace is vital, however, given that these missions are often launched at short notice, military use of airspace is immediate and by default less predictable requiring more dynamic arrangements for securing efficient military operations without negatively impacting an efficient overall flow of air traffic. For this reason, the wide military involvement has been and still is paramount for SESAR solutions to enable effective military missions and airspace usage to be integrated with other users of airspace across Europe.

In 2016, the military community participated in various projects coordinated by EUROCONTROL on behalf of the SJU relating to the needs of the projects and the military community. Cooperation with EDA (see below) was strengthened and a specific brochure was developed by EDA to clearly articulate the military community strategy towards SESAR.

### 1.3.1.6.1 The European Defence Agency

The SJU and the European Defence Agency (EDA) have been engaged in close dialogue since 2011 and this relationship continues to provide input on military matters and opinions into the Programme. Several ministerial mandates and EU Regulations (CIR 409/2013, new proposal of Basic Regulation) set the responsibilities for EDA to facilitate the coordination of military views with regard to Single European Sky and SESAR. In 2014, EDA established a specific ad-hoc programme "Military Implementation of SESAR (MIOS)" which allows for additional military expertise in this domain within EDA CPS Directorate. This programme allows for reinforced engagement with SJU and was further exploited during 2015. In general, the 2015 collaboration between the EDA and SESAR focused on:

- Establishing all SJU military coordination through EDA incl. NATO;
- Master Planning (2015 campaign)
- Defence investment and procurement;
- Planning for the evolution of relevant military technologies;
- Risk mitigation actions related to military implementation of SESAR;
- Provision of expertise or organisation of fora to gather the required results in key areas.

In 2016, the relationship with EDA grew to cover the complete military dimension of SESAR. This relationship and with the needs of ramping up the SESAR 2020 programme a revised Memorandum of Cooperation between the SJU and the EDA was agreed and signed in December 2016 with an initial Steering Committee convening directly after the signing event. Specific areas of concern for EDA are well covered in the current working arrangement such as but not limited to, UAS/RPAS

integration and the key capabilities, European ATM Master Plan coordination and the international dimension of SESAR.

### 1.3.1.6.2   NATO Coordination

The SJU established coordination with the NATO Group responsible for Air Traffic Insertion to enable NATO to formulate its planning in a harmonised manner with SESAR. Technical and programmatic advice was given and was welcomed by the NATO group since they have long planning horizons and a need to ensure interoperability without compromising the military mission.

### 1.3.1.7   Civil Airspace Users

Civil airspace users (AUs) cover a wide spectrum of activities and undertakings, ranging from scheduled and charter airlines, cargo service providers to business and general aviation, including rotorcraft operations.

Civil airspace users are directly integrated within the Programme through the third party arrangements above and their expertise is recognised as key in ensuring the overall success of SESAR.

In 2016 the airspace users participated in SESAR projects, providing substantial expertise into reviewing and commenting SESAR Project closure deliverables, and also participating in actual exercises, large scale trial demonstrations with a particular focus on delivering PCP related activities, allowing assessing actual feasibility and testing the quality of SESAR Solutions and the benefits generated from their implementation.

To prepare for the launch of SESAR 2020 and summarize SESAR 1 findings, they also delivered in December 2016 a substantial document summarising key technical inputs to establish a bridge between SESAR 1 and SESAR 2020. With the closure of SESAR 1, all Airspace User contracts were terminated and a new procurement was launched to ensure continued direct airspace user engagement in the context of SESAR 2020.

### 1.3.1.8   Professional Staff Organisations

The SJU collaborates closely with all relevant Professional Staff Organisations through the third-party arrangements above represented by the participation in the programme of the following five organisations: International Federation of Air Traffic Controllers' Associations (IFATCA), European Cockpit Association (ECA), International Federation of Air Traffic Safety Electronics Associations (IFATSEA), European Transport Workers' Federation (ETF), and Air Traffic Controllers European Union Coordination (ATCEUC).

The integration of Professional Staff Organisations' representatives into the Programme at different levels remains in place and a pool of 90 licensed and operational controllers, pilots and engineers of all nationalities continue to work on the International Validation Team (IVT).

In 2016, the last of the 4 times yearly coordination meetings under the EUROCONTROL contract (on behalf of the SJU) too place with Professional Staff Organisations. Work with the SJU and in the projects was concluded with good results thanks to the PSO´s input on the operational perspective of SESAR Solutions. Safety Resilience and Human Factors issues was studied in a separate activity but integrated into the relevant projects. The last quarter of 2016 was concentrating to develop a revised MoC between the SJU and the PSO´s to fit under the SESAR 2020 Programme.

### 1.3.1.9    Airports Council International, Europe

Recognising the need for further airport integration, the SJU works closely with Airports Council International (ACI) to raise awareness about SESAR among airport partners – beyond the hub operators represented in the SESAR European Airports Consortium (SEAC 2020).

In 2016, the close collaboration between ACI Europe and the SJU was continued allowing an efficient and constructive relationship, materialised by a new framework contract established in 2016 (see section 1.5.3.3 on Legal & Procurement). Amongst the activities the following can be mentioned:

- ACI Europe and the SJU organised two roadshows to promote airport related SESAR R&D and deployment activities. These roadshows took place at Riga airport on 20 October 2016 and at Bratislava airport on 15 November 2016. They each attracted 15-20 airport stakeholders from the local airport but also from the catchment area around the airport, including airport operators, ANSPs, regulators, researchers and airspace users. The roadshow presented the SESAR solutions susceptible to be deployed locally and some regional SESAR initiatives. It allowed the participants to better understand how SESAR will bring concrete short term benefits to their operations;
- ACI Europe reviewed documents constituting SESAR Solutions #21 Airport Operations Plan and AOP-NOP Seamless Integration on behalf of the SJU, bringing a wider airport point of view on the solution, reinforcing its applicability to a wide range of European airports and contributing to its delivery;
- ACI Europe supported the SJU in communication activities by publishing several SESAR related news items and articles in ACI Europe's newsletters and magazine;
- ACI Europe and the SJU organised a workshop on Performance-Based Navigation (PBN) and Noise on 28 November 2016 to provide insight into the results of SESAR 1 in relation to PBN and noise, share experience from local PBN implementation initiatives and potentially identify further R&D needs. The workshop attracted about 50 participants representing airport stakeholders, ANSPs, airspace users, industry providers, research institutes and European institutions. The workshop allowed the participants to identify a number of challenges and recommendations related to the development and deployment of PBN and noise related solutions.

### 1.3.1.10   General Aviation

The SJU continued to engage with the general aviation community during 2016 including providing a presentation to the PPL/IR  sub-group of Europe Air Sports, comprising GA operators with full IR qualification and equipage as an important but often-overlooked community to promote buy-in and awareness in that community of developments in SESAR and how they might be affected by them.

### 1.3.1.11   Space activities

The European ATM Master Plan clearly identifies the need for space-based positioning for navigation and communication services in support of time-based and trajectory-based operations, as well as for improved operations into less well-equipped airports or with differently-equipped vehicles.

In 2016, the SJU organised and chaired series of meetings with the European Space Agency (ESA) and Inmarsat as part of the SatCom coordination group. Furthermore, on September 15th, 2016, signed a new Memorandum of Cooperation (MoC) with the ESA. This allowed coordination between ESA/Inmarsat lris activities and the SJU 15.2.4/15.2.5 projects. This activity allowed the development of a shared view on the value chain and interdependencies between both programmes.

Furthermore, during 2016 a coordination group was established with the European GNSS Agency (GSA), DG MOVE and DG GROW to coordinate activities related to GNSS.

This includes provision of SESAR views and exchange about potential overlaps, content issues, scope of ongoing and future calls and the development of a joint dashboard of GNSS projects/calls to avoid duplications and better manage the interdependencies.

### 1.3.1.12  Clean Sky

The SJU continued the work of close coordination with the Clean Sky JTI, focusing on specific areas of common interest such as:

- Gate-to-gate aircraft operational improvements (WP16) for fuel and environmental savings, environment metrics and modelling and the Clean Sky Technology Evaluator work;
- Aircraft Systems in support of SESAR Trajectory-Based Operations (WP9) and Clean Sky Trajectories for Green Operations.

In 2016, the cooperative arrangements with Clean Sky continued but now under the revised Memorandum of Cooperation signed in December 2015. The cooperation in 2016 also covered areas like rotorcraft and general aviation capabilities and procedures, environmental performance measures and goals and to explore Clean Sky's process and relationship SME´s in European regions.

## 1.3.2  International Affairs

The SJU continues to engage in international activities in the framework of the EU Aviation Strategy and in close coordination with the European Commission. The principal objectives are to secure SESAR's position as a global leader in ATM modernisation in support of ICAO's Global Air Navigation Plan (GANP), to support EU industrial leadership and to focus on SESAR Solutions for global interoperability and harmonisation.

During 2016, the SJU continued its international relations work at ICAO and at bilateral levels. At the level of ICAO, the SJU worked closely with the European Commission to prepare the EU's position for the 39th ICAO General Assembly at the end of September, in particular to ensure that Europe's ATM-related priorities were taken fully into account in ICAO's future work to update the GANP and in the standards development processes. The SJU participated to the European ICAO ATM Coordination Group together with the EASA, EUROCONTROL, ECAC and EUROCAE.

The SJU maintained its close cooperation, both formally and informally, with the FAA and its NextGen programme. Under Annex 1 of the U.S. – EU MoC on Civil Aviation Research and Development, the SJU and FAA jointly published the second edition of the NextGen-SESAR State of Harmonisation document in November 2016, summarising the latest achievements and state of play in the collaboration between the two programmes. Highlights include delivery of an air-ground data communication strategy involving industry on both sides, successful demonstration activities to showcase the global interoperability of SWIM data exchange for applications using flight information exchange models and technologies, and integration of the full ATM lifecycle from planning, development and deployment into the collaboration with the FAA. The transition of SESAR-1 solution to deployment, led to a new challenge on international coordination that involves new actors on both the US and the European side. Effort was spent to align international coordination that now includes the deployment bodies (SDM on European side) as well.

NextGen and SESAR have together made significant progress in several critical areas since the publication of the first edition of the State of Harmonisation in 2014. The updated State of Harmonisation was published in 2016 (see section 1.3.3.2).

In September 2016 the SJU signed a Memorandum of Cooperation with the UAE General Civil Aviation Authority (GCAA), which will provide a basis for enhanced collaboration on ATM modernisation in order to contribute to the development and harmonisation towards global interoperability. Adding to the Memorandum of Cooperation already in place between the SJU and Singapore and to the cooperation frameworks already active between the European Commission and third-party countries (EC Memorandum of Cooperation with Japan, Letter of Intent with China, Memorandum of Understanding with Mexico), the scope of the collaboration between the parties includes the sharing of information, knowledge and expertise and co-operating in activities related to ATM modernisation.

### 1.3.3   Communication activities

Communication and marketing plays an integral role in engaging with and informing the wider air transport community about the SESAR JU's work and results. This work also encourages wider international commitment to the Single European sky (SES) approach to ATM modernisation and also contributes to maintaining the momentum around the SESAR project.

In 2016, the SESAR JU carried a number of communications activities in accordance with the objectives of its 2015-2020 Communications Strategy to recall the achievements of SESAR 1 and mark the launch of the first projects under SESAR 2020. The following is a summary of activities undertaken by the SESAR JU.

#### 1.3.3.1   Events

Over the course of 2016, the SESAR JU organised a series of events to maintain a high profile and engagement with relevant stakeholders across the ATM community. In addition, SESAR JU staff participated in over 100 further events, raising the visibility of the SESAR project. The following are highlights from events in which the SESAR JU actively participated:

**World ATM Congress, 8-10 March 2016, Madrid**

From 8-10 March 2016, SESAR participated in the World ATM Congress 2016 where the SESAR Exchange Theatre – co-hosted by the SESAR JU and the SESAR DM - provided an opportunity for the audience to hear the latest on SESAR research and innovation (R&I) and deployment activities.  In particular, the SESAR JU held sessions on virtualisation, ground-to-ground interoperability, the European ATM Master Plan and spectrum. The event was also the backdrop for an announcement on the SESAR 2020 membership, the SESAR project awards and the first ever Single European Sky Awards ceremony.

**SWIM Global Demo, 8-9 June, Rome**

From 8-9 June 2016, SESAR and more than 150 partners from around the globe demonstrated how seamless and efficient information exchange is possible across world regions, thanks to the system-wide information management (SWIM) framework. Organised by the SESAR JU and hosted by ENAV, the global demonstration conducted live demos and showcased examples of SWIM business solutions already in operation and the benefits they are delivering. In particular, the partners showed the technical feasibility of connecting different local implementations of SWIM, exchanging

information in areas such as aeronautical, meteorological, and flight and network information through globally common SWIM standards.

### SESAR Showcase, 14-16 June, Amsterdam

With SESAR 1 activities coming to a close, the SESAR JU organised an event that showcased and acknowledged the achievements of the first SESAR programme, demonstrating that SESAR is already delivering tangible solutions to the aviation industry and society as a whole. The event took place from 14-16 June at the Nemo Science Centre in Amsterdam. Bringing together more than 500 participants, the event showcased SESAR work and results achieved to date, industry/stakeholder operational/business perspectives and experiences/expectations as well as what comes next in the SESAR programme, with a view on SESAR 2020, upcoming standardisation activities and the SESAR Deployment Programme.

### SESAR Innovation Days, 8-10 November 2016, Delft

The European aviation academic community are generating valuable new ideas for the modernisation of air traffic management. This was clear to see at the sixth edition of the SESAR Innovation Days (SIDs), organised by EUROCONTROL, which took place between 8 and 10 November at TU Delft in the Netherlands. Over the three days, Europe's brightest minds in aviation research presented results from exploratory research projects. The event also served to present SESAR 2020, its scope of activities and how the programme is encouraging the flow of the results from exploratory research into the industrial research activities. Bringing together more than 200 participants from both Europe and further afield, the event featured a number of keynote presentations, panel sessions and poster sessions highlighting some of today's most exciting research taking place in the field of air traffic management (ATM).

### EU Agencies Forum, 6-7 December, Brussels

From 6-7 December 2016, policy makers, representatives of industry, civil society, EU institutions and public administration gathered at the European Parliament for a major conference dedicated to the work and contribution of the 45 EU Agencies and Joint Undertakings, including the SESAR Joint Undertaking. The aviation industry stressed that SESAR is delivering and underlined the importance of supporting such projects for the ongoing competitiveness and sustainability of European industry. The event also presented a study on the value how the Agencies contribute to the Europe 2020 strategy and the Juncker Agenda on various aspects of our everyday lives.

### 1.3.3.2    Publications

A number of publications were prepared throughout the year for dissemination via online channels and at key events (see above):

| | |
|---|---|
| SESAR 2015 Highlights | The SESAR highlights brochure combines the milestones achieved in 2015 of the SESAR Joint Undertaking and SESAR Deployment Manager and gives a taste of what's coming up for the project in 2016. The brochure reflects the spirit and determination of both the SESAR Joint Undertaking and SESAR Deployment Manager to deliver together a modernised ATM system for Europe. |
| SESAR Virtual Centre factsheet | The factsheet explains the virtual centre concept, why it is needed and the expected benefits. The factsheet also details what research work has been done in SESAR on the concept as well as the next steps to complete the work. The factsheet was produced for a dedicated session on virtualisation at the World ATM Congress. |

| | |
|---|---|
| SESAR Release Results 3 and 4 | Release 3 and 4 delivered a total of 11 solutions deemed mature enough to go forward for industrialisation, while making significant progress on 13 solutions for which further research is required. This section describes these solutions, the steps taken to validate them and the results to prove their readiness. |
| SESAR: from vision to reality (the story so far) | Marking the closure of SESAR 1, the book captures key moments of the SESAR project, including the challenges that triggered the pioneering idea of establishing the Single European Sky and SESAR. More specifically it covers the story of the Joint Undertaking, from pooling public and private resources to defining the roadmap for ATM modernisation and forging ahead the most promising research results into real ATM operations. |
| SESAR Solutions Catalogue and Solutions Catalogue in a nutshell | This first edition of the Catalogue draws together more than 60 SESAR Solutions delivered by SESAR JU members and partners to modernise Europe's air traffic management system. The contents of this first edition range from baseline or quick-win solutions to those that address more complex operations. They cover solutions which have been fully validated and documented, with the majority confirmed as ready for implementation. The catalogue is complemented by a smaller executive summary of the solutions contained in the catalogue.<br><br>The Catalogue was presented to the ATM community during the SESAR Showcase even (see above in section 1.3.3.1), and to Ms. Violeta Bulc, Commissioner for Transport on 17 June 2016. To complement the catalogue, an interactive map offers a graphical representation of the solutions grouped by phase of flights. [21] |
| Integrating drones in European airspace | In line with the European Commission's "Roadmap for the integration of civil RPAS into the European aviation system", in 2013, the SESAR Joint Undertaking launched its first remotely drone activity, the co-funding of nine demonstration projects. Bringing partners together from across ATM and Europe, the projects aimed to fly a category of drones called remotely piloted aircraft systems (RPAS) in non-segregated airspace in order to test what was possible within the current regulatory environment using existing technology. This brochure provides an aggregated summary of the results from these projects. |
| NextGen - SESAR State of Harmonisation | NextGen and SESAR have together made significant progress in several critical areas since the publication of the first edition of the State of Harmonisation in 2014. The purpose of this second edition is to provide a high-level summary of the current state of progress towards achieving the necessary level of harmonisation and global interoperability between NextGen and SESAR. More broadly, the publication reflects the current and planned collaboration efforts by the United States and the European Union to harmonise and secure the modernisation of air traffic management not just transatlantically, but globally in support of the International Civil Aviation Organisation (ICAO) Global Air Navigation Plan (GANP) and its Aviation System Block Upgrade (ASBU) programme. |
| 2015 SJU Consolidated Annual Activity Report | The report provides highlights of the work undertaken by the SESAR JU and its members over the course of 2015. |

**Table 6: SESAR publications in 2016**

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[21] The SESAR Solutions catalogue and the SESAR Solutions map are available on the SJU website:

http://www.sesarju.eu/sites/default/files/documents/reports/SESAR_Solutions_Catalogue_0.pdf

http://www.sesarju.eu/solutions-map

Founding Members

EUROPEAN UNION    EUROCONTROL

In addition to these publications, the SESAR JU supported SESAR members by validating the content of dedicated project brochures and flyers.

### 1.3.3.3    Online communications

#### 1.3.3.3.1    Digital media

The SESAR JU dedicates significant resources to developing short animations and videos about the work of the programme. In 2016, the SESAR JU produced the following digital material which is disseminated through various channels.

**European ATM Master Plan**

This animation gives a brief overview of the European ATM Master Plan, the main planning tool for ATM modernisation in Europe. The animation was used to promote the publication of the second **edition of the Plan during the World ATM Congress 2016.**

**Best of SESAR**

This video summarises the achievements of the SESAR JU public-private partnership, and was used to open the SESAR Showcase event in Amsterdam.

**SESAR Solutions interactive map**

To complement the publication of the SESAR Solutions catalogue, an interactive map was launched offering a graphical representation of the solutions grouped by phase of flights.

In addition to this digital material, the SESAR JU supported SESAR members by validating the content of dedicated project animations and videos.

**SESAR mobile app**

The SESAR JU further promoted the use of its mobile application during all of its events, which enabled strong interaction between speakers, moderators and the audience.

#### 1.3.3.3.2    Website

In 2016, the SESAR JU maintained its online readership with over 100.000 visitors to its public website and nearly 400.000 page views. A monthly e-news was sent to external audiences (nearly 25.000 contacts), as well as dedicated event mailshots and press releases attracting further readers to the SESAR JU website. Among the most popular news stories were the SESAR SWIM Global Demo, the publication of the SESAR Solutions Catalogue, the European ATM Master Plan and the results of the ELSA study. SESAR 2020 news were also popular, such as the membership announcement and news of the first research project getting underway.

#### 1.3.3.3.3    Social media

The SESAR JU continued significant use of social media in 2016, in particular Twitter (1.810 followers), which proved to be an effective means to engage with stakeholders at events and promote validation and demonstration activities. The SESAR JU also continued to engage with stakeholders through LinkedIn (5.097 members) through regular postings. The SESAR YouTube saw an increase in visits compared to 2015 (42.000 views), as well as a significant increase in watching time thanks to the live streaming of the SESAR Showcase.

### 1.3.3.4 Press

In 2016, SESAR JU continued its outreach to trade press and member/partner media channels, with featured articles and interviews in a range of magazines and online media:

- Trade or specialised press, including International Airport Review, IHS airports, Airport Business, etc.;
- Brussels-based press such as the Parliament Magazine, European Network, Commission Directe, etc.;
- Member/partner media (NATS, EBAA, ICAO Journal, EUROCONTROL's Skyways, ERA, ATAG, RTCA, etc.).

Over the year, the SESAR JU issued press releases on the following: SESAR Showcase, signature of a number of memoranda of cooperation and understanding, SESAR 2020 membership, publication of the Drone Outlook Study.

The SESAR JU also hosted a dedicated press briefing during the SESAR Showcase event, which resulted in coverage in national press as well as coverage by trade press, such as Aerospatium, ATC Network, Air traffic Management Magazine, Jane's Airport Review, Hispaviacion, among others.

## 1.4 Area of Operation 4: Assist stakeholders in other areas concerning the technological pillar of the Single European Sky initiative

> *Objective and target achievement status at the end of 2016: the RPAS Outlook Study was completed at the end of Q3 and the ELSA study on Datalink by Q4*

In addition to the activities presented in the previous sections, in 2016 the SJU continued to assist its stakeholders on a number of areas relating to the contribution of the SES technological pillar in other areas of the Single European Sky initiative. This included continued technical assistance to SESAR policy makers on specific tasks such as SWIM, Datalink, Cyber-security, RPAS and CNS, and other topics, details of which are outlined below.

### 1.4.1 Datalink – ELSA study

Following the launch of the VDL/2 ATN datalink study (ELSA) in 2015 the SJU continued to work closely with the ELSA consortium partners on the finalisation of the ELSA delivery and reports. This included close steering and review of all of the material resulting in clear and justifiable reports and recommendations for the next steps in terms of datalink recovery. The SJU continued to chair the Datalink advisory group involving the NM, EASA, SDM, SJU and the EC ensuring a common institutional view of the required VDL/2 recovery actions. Advice and support was provided to the SESAR DM on the subsequent development of the Datalink Recovery Plan. The SJU provided support to the EC for the preparation and running of a datalink workshop (24 November, 2016) to engage with the wider stakeholder community on the way forward for datalink.

Coordination on the development and role of satellite communications developments in SESAR took place throughout 2016 with the European Space Agency and Inmarsat including the definition of

specific coordination between ESA/Inmarsat Iris activities and the SESAR 1 15.2.4/15.2.5 projects. This resulted in the development of a shared view on the value chain and interdependencies between both programmes.

Under the framework of the US/EU coordination activities during 2016 there was the development of a harmonised EU/US datalink strategy. The SJU lead the European contribution to this Joint EU/US Air/Ground Communications Strategy, aligning the views and agreement on the convergence target, challenges and opportunities. This resulted in the delivery of a datalink harmonisation report in Sept 2016

### 1.4.2   SWIM

The SJU organised the SWM Global Demo, as well as the European participation to the FAA's Mini Global II. Both demonstrated the maturity of the SWIM concept, show casing live SWM-interoperability of meteorological, aeronautical, flight and network management information between global partners in a mixture of operational and prototyped systems. Global partners include the US, Brazil, Australia, Mongolia and the United Arab Emirates. Key contributions include reaching out to and getting commitment from global partners, taking over as fall-back for operational input, project management and event organisation, and authoring the papers feeding back to ICAO on architecture and lessons learned.

EUROCAE's working group 104 was kicked off as a pilot to standardize the Extended Arrival Management service, based on SWIM principles. As SWIM separates out information model, logical service definition and technical profile as individual standards, the challenge is still ongoing to define and agree the format of the EUROCAE standard on the service definition in its relation to non-EUROCAE standards on information models like AIRM, AIXM, FIXM, WXXM with their own global CCBs and the SWIM TI Yellow profile being standardized by EUROCONTROL.

A presentation on SWIM was provided to NATO, as that body was very interested to adopt the SWIM principles in their ACCS architecture.

### 1.4.3   Cyber-security

The future European ATM System must be secure and resilient in order to support EU goals of modernisation of the ATM sector in line with the growth projections in European air traffic. In 2016 the focus continued to be on creating an effective cyber-security approach in a SWIM-enabled environment with critical infrastructure requiring the adoption of cyber-security management, enabled to secure information and protect ATM against cyber-threats.

The results of the 2015 cyber-security study have provided the foundation for the development of a cyber-security strategy during 2016. It defines a coherent approach to address cyber-security aspects in R&D, aiming to deliver securable solutions through a cyber resilient architecture in SESAR 2020 and will be applied across the programme in 2017. This strategy should be seen as a significant contributor to the ability to deploy new ATM systems in a secure way.

It is clearly recognised that the responsibility for cyber-security goes beyond SESAR and beyond ATM to the wider aviation community. As such in 2016 links have been established across the aviation industry on this important topic .Security progress of SESAR was presented at EASA's High Level Security meeting in Bucharest, at the SAGAS (Stakeholders' Advisory Group on Aviation Security) and at an Airport security workshop. Contacts have been established with the Shift2Rail Joint

Undertaking for future coordination on cybersecurity. The SJU is a member of the Steering Committee of the GAMMA project.

Additionally, in November 2016, a study on cyber-security at airports, led by EUROCONTROL in support of the SESAR programme, was delivered, which applies SESAR security risk assessment methodology to investigate cyber-security risks at an Airport Operations Centre (APOC). This is done through the exploration of a number of attack scenarios ranging from simple Distributed Denial of Service (DDoS) attacks to sophisticated attacks as well as low-level attacks on power and water supply, airco, security cameras etc. For each scenario, an assessment is done with respect to their impact on operations and business and the vulnerabilities that enable such attacks. The study concludes with the identification of corresponding security controls. Key technical controls required for an APOC include intrusion prevention/detection, data diodes (to protect read-only data, such as relating to passengers), logging and audit capabilities, device and service authentication and data validation tools that will also increase the general robustness for airports.

### 1.4.4   UAS/RPAS/Drones

With the new focus on the issue of drones and RPAS integration with ATM during 2016 a number of activities took place.

#### 1.4.4.1   The Drone Outlook Study

The SJU commissioned a Study 'Drone Outlook Study' looking at the outlook for the growth of the drone industry in Europe to support European planning to support its development. The SJU provided expert advice to the authors during the study, including technical review of the final deliverable which was essential in achieving a credible and usable report.

With substantial activity in the domain of RPAS the SJU established a close coordination with the European Defence Agency (EDA) to ensure harmonisation between EDA and SESAR RPAS projects. This included SJU participation in the evaluation of responses to a key EDA RPAS Call, the review of the output of a major EDA RPAS project and contributing to the specification of an EDA RPAS Call specification. Briefings on SESAR's plans and activities to promote harmonisation were also provided.

The SJU provided expert input to the members of DG MOVE and DG GROW who were responsible for the definition of a European Commission approach to facilitating the growth of the drone industry in Europe.

The Drone Outlook study was published in November 2016 in the context of the Warsaw conference on drones.

#### 1.4.4.2   European Parliament's assigned revenue for Geofencing Very Large-Scale demonstrations

The commitment was made in 2016 with initial planning to allocate this budget to a call on Exploratory Research and Very Large Scale Demonstration (2016-2) in a separate topic specifically addressing drone geo-fencing demonstrations.  This call would have used both H2020 funds and the assigned revenue (non-H2020) each allocated across separate topics, but despite their being no obvious rule preventing this approach the SJU was advised by the Commission that due to the different rules applicable to the separate sources of finance it was unwise to combine them in one call thus avoiding IT tool configuration issues and risk on non-compliance with the respective financial rules.

So as not to delay this important topic the SJU included geo-fencing for drones in the scope of its H2020 call 2016-2 and had already issues a call for Exploratory Research into RPAS (Drones) in the call 2016-1. Consequently there are already relevant calls that should result in some action on the subject and in the timeframe previously agreed.

In order to award grant(s) for the assigned revenue, the SJU has listed a new and separate call in its Single Programming Document (SPD) for 2017 and this is timed to be opened just after the SJU has completed its evaluation of second of the 2016 calls (Q2 2017); the approach being to target specific research as a to 'gap-fill' and ensure that sufficient funding is available to demonstrate the geo-fencing concept.

### 1.4.5   Communication, Navigation & Surveillance (CNS)

On request of the European Commission, the SJU began the development of a SESAR CNS and Spectrum strategy document, which will be finalised in 2017 to be integrated in the next Master Plan update.

### 1.4.6   IOP recovery activity

Following the identification of issues between the SESAR delivery of the "IOP" FDP exchange solution and the associated standardisation work within EUROCAE there was a decision by the SESAR 1 PC to create 2 ad hoc teams to monitor and progress the issue. A Decision Team (DT) and Analysis Team (AT) were established to tackle the identified issues on Interoperability. This has allowed the SJU to steer the work to achieve a set of operational and technical requirements mature enough to progress towards the target set by the PCP regulation according to the revised IOP Roadmap. In addition the SJU has supported EUROCAE with regard to the work and planning of WG-59 on the identification of the way forward for the publication of ED-133 rev.A.

## 1.5 Area of Operations 5: Provision of an effective organisation to support delivery of SJU's mandate

*Objective and target achievement status at the end of 2016: ADB and ED decisions and SJU internal procedures were successfully transited to SESAR 2020, and SJU staff was trained accordingly at end of Q4. The effective implementation of the processes is in progress and monitored in view of their continuous improvement*

*Furthermore, the SJU has been subject of several audits from IAS, ECA and the Internal Audit Capability. Recommendations from these audits (none of which was critical) have been registered and action plans are defined and implemented. Similarly, observations from the European Parliament (none of which was critical) have been acknowledged and worked upon. The European Parliament granted discharge to the SJU regarding financial year 2014*

In the course of 2016, the SESAR JU implemented the transformation of its management framework initiated in 2015 to adapt to new requirements stemming from H2020 regulation, while ensuring the continuity of its management tasks.

### 1.5.1 Transforming the SESAR JU's management framework to adapt to H2020 requirements

From an administrative point of view, during 2016 the SJU continued to adapt its corporate, legal, administrative and financial processes and its organisation to ensure compliance with Horizon 2020's legal, financial and administrative framework. Building on the analyses conducted in 2015 to understand the impacts on existing processes and on the organisation structure, the SESAR JU implemented a profound transformation of its renewed management framework, consisting in:

- an adapted organisation structure, revising the existing roles and responsibilities and introducing new roles directly related to H2020 in the organisation: the roles of Call Coordinator and Grant Managers (dedicated positions were opened in Q2 2016 and filled in October 2016),
- a renewed quality management system for the SESAR 2020 programme, with a complete set of programme and grants management processes aligned with H2020;
- a revised information system, adopting H2020 tools (EMI, COMPASS, etc.), and implementing their impacts on processes as well as having implemented in these shared tools SJU-specific adaptation and functionality to manage and amend grants in accordance with the constraints and obligations,
- and trainings delivered to staff to make this transformation effective.

This transformation is to a large extent completed at the end of 2016, and the SESAR JU is now running and refining its SESAR 2020 operations following a continuous improvement approach.

SJU staff also participated in a number of H2020 coordination groups: H2020 Common Support Centre Executive Meeting; H2020 Network of Lawyers; H2020 Single Point of Contact meetings; H2020 Participant Portal committee; H2020 Dissemination and Exploitation Practitioners Platform (DiEPP); H2020 Coordination of audits in the Research family (CAR); H2020 Fraud and Irregularity in Research Committee (FAIR).

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### 1.5.2 Transforming the SESAR JU's governance

A significant amount of changes in the governance of the SESAR JU and of the SESAR programme were implemented in 2016. These are materialised amongst others with renewed Terms of Reference approved by the Administrative Board in December 2016.

#### 1.5.2.1 Changed membership of the Administrative Board

The Administrative Board is composed of representatives from each Member of the Joint Undertaking and 7 representatives from different stakeholders, and is chaired by the representative of the European Union, represented by the European Commission Director General for Mobility and Transport. The vice-chairperson is the DG of EUROCONTROL.

During 2016, the Administrative Board (ADB) met three times (in April, October and December) and the meeting held in October was the first one including representatives of the Members who joined the SJU in 2016, adopting the updated share of contribution to the SJU and the respective voting rights.

The ADB continued in its role to ensure that the SJU delivers the tasks and results as stipulated in its establishing regulation in the most effective way, taking into account the strategic goals and objectives of the SJU and focusing on the following high-level tasks:

- Setting and monitoring the strategic direction to guide the activities of the SJU;
- Ensuring the timely delivery of SESAR 1 results
- Monitoring the transition to SESAR 2020
- Monitoring the activities of SJU to ensure they remained in line with its long-term strategy and mission, vision and values.

#### 1.5.2.2 Changed membership of the Programme Committee and adaptation of the programme governance

In line with the evolution of the membership of the SESAR JU, the membership of the Programme Committee was renewed to include representatives of each of the contributing Members of the Joint Undertaking (including EUROCONTROL), and one representative of civil Airspace Users and one of the European Commission (DG MOVE) as permanent observers. The role of the Programme Committee remains to support the SJU Executive Director in the management of the Industrial Research & Validation and VLD phases of the SESAR 2020 programme. From 2017, the Programme Committee will be supported by two sub-committees: the Delivery Management Sub-Committee (DMSC) focusing on the management of the programme and of the various contributions, and the Operations and Technical Sub-Committee (OTSC) focusing on the content steering of the activities.

#### 1.5.2.3 Renewed Scientific Committee

The Scientific Committee supports the SJU Executive Director in assuring the scientific excellence of the SESAR 2020 Programme. In particular, this Committee will, under the chairmanship of the SJU, take a monitoring view (content and results) over the Exploratory Research activities of the SESAR 2020 Programme and transition to industrial research and validation, while also providing the ED with scientific advice covering the whole range of SJU's SESAR 2020 research activities. In order to foster transition between Exploratory Research and applied and industrial research an observer seat is reserved to a representative of the Programme Committee. The committee member seats were filled in 2016 by an open call for scientists and researchers from across the research community a

representative from each of the Founding Members (EC on behalf of the EU and EUROCONTROL) and a representative of the Programme Committee.

### 1.5.2.4 The ATM Master Planning Committee: introduced to oversee the European ATM Master Plan

The ATM Master Planning Committee provides expert advice and recommendations to the SJU Executive Director on the maintenance, execution and update of the European ATM Master Plan and contributes to maintaining a strong connection between the SESAR development and deployment activities.

It is composed of representatives of the European Commission, EUROCONTROL, the Network Manager, civil users of airspace, the military, air navigation service providers, ground equipment manufacturers, airborne equipment manufacturers, airports, professional staff organisations in the air traffic management sector, the SESAR Deployment Manager, EASA and Eurocae.

The Master Planning Committee has been prepared in 2016 to hold it first meeting in early 2017.

## 1.5.3 Other management and support activities carried out in 2016

In 2016, while implementing all changes mentioned above, the SJU continued to fulfil its management, financial, legal and administrative obligations effectively, and implemented measures related to efficiency gains and cost control. These activities are presented in the following paragraphs.

### 1.5.3.1 Financial management & budget implementation

The final Budget, i.e. the amendment 2 of the Budget approved by the Administrative Board (written procedure) on 2 December 2016, included revenue appropriations for EUR 99.073.761 and payment appropriations of EUR 146.753.830. The actual (consumed) overall commitments amounted to EUR 88.405.761 (89,2% of the budget) and overall payments to EUR 143.212.022 (97,6% of the budget). The breakdown of these figures per revenue source appears in section 2.3.1.

In terms of expenditure, the final Budget as defined above included commitment appropriations for EUR 99.073.761 and payment appropriations of EUR 157.152.638. The actual (consumed) overall commitments amounted to EUR 97.113.654 (98% of the budget) and overall payments to EUR 102.973.228 (65,5% of the budget). The breakdown of these figures per revenue source appears in section 2.3.1.

With the SJU being a multi-annual programme of a limited life-time and with fixed total budget ceilings, unused payment appropriations at the end of one budgetary year are not cancelled but inscribed as Budget Result in the revenues of the subsequent budget, to be presented to and adopted by the SJU Administrative Board in accordance with the SJU Financial Rules. The provisional Budget Result 2016 (i.e. total revenues of EUR 143.212.022 minus EUR 102.973.228 total payments) amounted to EUR 40.237.981. The 2016 surplus that remains within the Joint Undertaking amounts to EUR 37.043.018 (EUR 40.237.981 gross payment surplus minus EUR 3.194.962 carry-over for Titles I & II).

### 1.5.3.2 Human Resources management

The SJU staff consists of 42 positions, as per the Multi-Annual Staff Policy Plan 2014 – 2016. Moreover, for the period 2016-2017, the SJU has been authorised 2 additional CA positions to

support administrative transition from SESAR 1 to SESAR 2020, hence 44 positions were planned for the year 2016. The Staff Establishment Plan and its realisation are presented in part IIa section 2.4.

The effective allocation of staff resources also remained a priority for the SJU during 2016. Efforts were focused on the professional and career development of its staff, in addition to ensuring that allocated staff resources are used in the most economic, efficient and effective way. For the second year, in 2016 the SJU conducted its Career Development Review exercise and was able to conduct the reclassification of 7 staff members.

Other remarkable achievements in 2016 in the Human Resources area are the recruitment of several new staff members to fill positions, in particular in fields related to Horizon 2020 processes (1 Call Coordinator and 2 Grant Managers recruited).

### 1.5.3.3    Legal and Procurement

In 2016, the acquisition of goods and services continued and significant procurement procedures were carried out in relation with the preparation for SESAR 2020. All procedures were carried out in compliance with the SJU's Financial Rules to ensure fair competition amongst suppliers and the most efficient use of SJU funds.

A list of procurement procedures concluded during the reporting period is included in Annex I.3.

### 1.5.3.4    Corporate Planning and Reporting

In 2016, the SJU released its Consolidated Annual Activity Report for 2015, which was approved by the Administrative Board by written procedure on the 16 June 2016.

Furthermore, the programming and planning activities of the SJU evolved with the production of the Single Programming Document, as per requirements of the Framework Financial Regulation, in place of the usual Annual Work Programme. The Single Programming Document includes an annual (N+1) and a multi-annual (N+1 to N+3) work programme, and includes the N+1 Budget and Staff Establishment Plan. Its adoption by the Administrative Board includes the financing decision and the approval of the Staff Establishment Plan.

In 2016, the SJU produced and ensured the adoption of the Single Programming Document for 2017 ('SPD 2017', covering the year 2017 work programme and the period 2017-2019 work programme), and the production of the Single Programming Document for 2018 ('SPD 2018', covering the year 2018 work programme and the period 2018-2020 work programme), subject to submission to the Budgetary Authorities not later than in January 2017.

### 1.5.3.5    Corporate Quality Management

In 2016, the SJU further implemented its Quality Management System, with the description of processes covering 3 areas in priority:

- Processes required to ensure full compliance with the Internal Control Standards,
- Processes required to ensure full compliance with the Audit Universe,
- Processes required for the management of the SESAR 2020 programme, implementing the H2020 framework.

These developments were supervised by the QICT Committee, which met on a monthly basis.

Furthermore, to support its operations and processes, and following recommendations from the Internal Audit Service (see section 2.7.1), the SJU launched a project aiming at improving the way

reference information and documentation are managed: the Corporate I/DMS project (for Information and Document Management System), which has the purpose to:

- Provide an overall architecture and harmonised policy, standards and procedures for the management of reference information and documentation,
- Fill the gaps with a dedicated tool, for those parts of the reference information and documentation which is not managed on an adequate identified platform,
- Secure the archiving of documentation relating to SESAR 1.

After an analysis of the high-level requirements and the selection of the technology, a pilot phase has been launched at the end of 2016.

### 1.5.3.6 ICT management & Facilities

#### 1.5.3.6.1 Information & Communication Technologies (ICT)

2016 has been another very intense year in the Corporate Support ICT area with the closure of SESAR 1 and the migration of the whole infrastructure towards EUROCONTROL, replacing the existing ICT contracts. The support service and the network availability remained of high quality throughout the year, while the ICT Migration activities added a significant workload to the team throughout the year (especially from Q2 until Q4 inclusive).

In parallel to the ICT migration activities, the new computers have been rolled out to the entire organisation in Q2/Q3.

Also, in collaboration with Microsoft, during the second half of the year, ICT has been leading the Corporate Pilot DMS project to streamline document management within the Corporate Support sector. MS SharePoint 2016 technology has been used for this purpose.

#### 1.5.3.6.2 Corporate Support

**Facilities Management**

The SJU enhanced its security measures, together with an update of the physical traffic access flow through its floors following the tragic terrorist attacks in Brussels in March 2016 resulting in an ad hoc increased national alert level from 3 to 4 and ongoing EC YELLOW alert level. The improvement of the security of the parking area was also confirmed in February 2016 through the validation of the underground Car Park policy implemented in September 2015. Security tours were also organised and mandatory for each newcomer.

At the same time safety measures were also reviewed (installation of new medical kits, new visual safety signalisations…).

In parallel, advice has been requested to the EC OIB focused on an audit on prevention & protection matters to ensure that the SJU facility services delivers a productive, safe and secure working environment.

In terms of building facilities, 2016 was the year of putting into practice the day-to-day building management with new landlord and new property manager (September 2015) but also the year of entry into force of the new rental contract (March 2016): new working arrangements were set up in 2016, including regularisation of the charges. The USA office was closed at mid-2016.

**Experts Coordination**

The Expert Coordination process - Appointment, Contracting and Reimbursement - was revised in accordance with H2020 regulations and tools, and several users were supported on the use of the new tool EMI interfaced with ABAC.

The engagement of experts for the SESAR 1 closure also brought additional workload, which was fully performed in respect of payment terms.

**Mission Coordination**

All Missions were executed on time and in line with the rules of the EC Mission Guide and approval.

Furthermore, a Call for Tender for travel agency services was published and successfully evaluated and awarded in 2016.

Necessary trainings were followed by the Facility & Expert Coordinators to upgrade their profile with the role of Financial Initiating Agent. Necessary changes were also implemented in the Corporate Support Sector in order to best meet the needs of the SJU and maximising the effectiveness and efficiency of the resources and the services provided.

### 1.5.3.7    Internal Control, Risk Management and Audit

Activities related to risk management and internal control framework are presented in part III.

Significant element is the adoption In March 2016 of the "SJU Anti-Fraud strategy 2016-2018" by the Administrative Board, including a detailed action plan. This strategy has been entirely tailor-made to addresses risks specific to the SESAR JU and is in compliance with the methodology provided by OLAF.

In this context, the SJU developed in 2016 Practical guidance for SESAR JU staff on red flags, whistleblowing, how to react and how to report fraud. Capacities were built through 2 training sessions on fraud awareness, prevention and detection. Additionally, a practical staff leaflet on "Anti-fraud guidelines for SESAR JU staff" was developed and distributed to all staff  and messages from management on ethics and fraud prevention were sent to SESAR JU staff during briefings and by email to ensure ethical and anti-fraud 'tone at the top'.

The following indicators are used by the SJU to report on the prevention and detection activities in the Annual Activity Report.

- Number and value of contracts/grant agreements subject to close monitoring or additional controls due to an assessment of a high risk of fraud,
- Number (and trend in number) of files sent to OLAF for investigation,
- Time elapsed between receipt by staff or management of first information on alleged internal fraud and transmission to OLAF,
- Time elapsed between OLAF requests for information and date when information is provided to OLAF,
- Time elapsed between receipt of an OLAF report and the decision on recovery or disciplinary sanctions by the SJU.

## 1.6 Overall risk level of SESAR JU activities at end 2016

In continuation with the approach followed in previous years, in 2016 the SESAR JU executed its risk management process which is described in section III of this document.

According to this process, while maintain the overseeing of all risk areas potentially affecting the achievement of the SJU objectives (Corporate risks), the Corporate Management focuses on critical risks. A risk should be considered significant if it falls within one of the following impact categories:

- jeopardises the achievement of strategic goals or effective implementation of the mandate of SJU,
- causes serious damage to SJU's stakeholders or partners,
- results in critical intervention at political level (e.g. Council/Parliament) regarding the SJU's performance,
- results in the infringement of laws and regulations,
- results in significant material and/or financial loss,
- jeopardises the safety of staff or,
- seriously damages the Joint Undertaking's image and reputation.

Recognising the mandate of the SESAR JU, Corporate risk categories managed by the SJU are threefold:

- **Internal risks** relating to the domains of finance and budget, human resources, legal and procurement, ICT etc.; these risks concern all units of the SJU;
- Risks associated with the **Master Plan** which are linked to the execution of the Master Plan (MP),
- Risks linked to the entire **SESAR 2020 Programme** (Exploratory Research, IR, VLDs) which impact the execution of the programme.

Risks under these categories are presented in the following 2 sections.

### 1.6.1    Internal SJU risks

At the end of 2016, risks under this category, and the related response actions, are:

| Ref. | Risk description | Criticality (Dec. 2015) | Criticality (Dec. 2016) | Risk owner | Summary of mitigation/response Actions in 2016 |
|---|---|---|---|---|---|
| ADM01 | Information is not managed properly, affecting the SJU's reputation and potentially resulting in lost opportunities for the industry with regard to the transition towards Deployment | Medium | Medium | SJU | Implement the DMS project for the whole SJU |
| ADM04 | A lack of connection between the SJU strategic objectives, the IT strategy and the IT project management framework might cause decreased effectiveness and efficiency of delivering SJU program 2020 | Medium | Medium | SJU | Put in place the ICT action plan to ensure the transition towards SJU 2020 |
| ADM05 | Lack of resources and capabilities to perform Procurement and Grant Preparation activities | Medium | Medium | SJU | Launch processes to recruit necessary additional staff |
| ADM06 | External factors may impact SJU's reputation in particular towards budgetary authorities | | Medium (New) | SJU | To be defined |

**Table 7: SESAR JU internal risk level and mitigation plan summary at 31/12/2016**

### 1.6.2   Master Plan and SESAR 2020 Programme risks

At the end of 2016, critical risks under these categories, and the related response actions, are:

| Ref. | Risk description | Type of Risk | Criticality (Dec. 2015) | Criticality (Dec. 2016) | Risk owner | Summary of mitigation/response Actions in 2016 |
|------|-----------------|--------------|-------------------------|-------------------------|------------|------------------------------------------------|
| RD02 | The R&D Programme does not deliver solutions that are ready for the preparation of deployment | ATM Master Plan execution | High | High | SJU | - Ensure consistency between the expectations outlined in the ATM Master Plan and the delivery of SESAR solutions in time and scope<br>- Deliver and publish SESAR Solutions Packs to prepare for the deployment of first SESAR R&D results |
| RD03 | Ineffective bridging between development and deployment activities may put industrialisation at risk and delay deployment | ATM Master Plan execution | High | High | EC, SJU, SDM, Standardisation Bodies | - Launch first wave of SESAR Very Large Scale Demonstration activities to bridge R5D with Deployment in the context of SESAR 2020<br>- Strengthen cooperation arrangements with Standardisation bodies to ensure alignment of their respective work programmes with the needs identified in the ATM Master Plan<br>- Strengthen current engagement of the regulatory authorities in the development phase to prepare for deployment |
| WSS02 | Governance Structure is not capable of ensuring successful Deployment | ATM Master Plan execution | High | High | EC, SDM, SJU, All Stakeholders | - Define and implement an appropriate Deployment Governance mechanism and efficient interaction of all parties involved in order to ensure an effective execution of the Deployment Programme consistently with the ATM Master Plan and the Network Strategy Plan.<br>- Governance has to ensure that the required resources are available for the timely local and synchronised deployment. |

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| Ref. | Risk description | Type of Risk | Criticality (Dec. 2015) | Criticality (Dec. 2016) | Risk owner | Summary of mitigation/response Actions in 2016 |
|---|---|---|---|---|---|---|
| WSS05 | Failure to manage Human Performance (Human Factors, Competency and Change Management) issues in the development and implementation of the ATM Target Concept | ATM Master Plan execution | High | High | SJU, All Stakeholders | - Ensure that operational staffs are included in development and validation activities<br>- Issue regular recommendations and activity plans for Human Performance in the area of R&D, regulation, standards, and management at industry level<br>- Monitor all SESAR oriented R&D and validation phases regarding Human Performance standards, methods and requirements<br>- Examine staff implications of all deployment activities for all groups of operational aviation staff and publish results and related recommendations<br>- Ensure appropriate coordination between all stakeholders concerned to ensure consistency between initiatives related to Human Factors, Competency and Social Dialogue |
| WSS06 | Delays in the implementation of the Pilot Common Project (PCP) | ATM Master Plan execution | High | High | EC, SDM, All Stakeholders | - Coordinate deployment to ensure timely and synchronized deployment of the PCP<br>- Synchronisation and coordination by SDM<br>- Ensure a strong promotion of the Deployment Programme<br>- Identify, stabilise and ensure implementation of elements that are prerequisite for SESAR deployment and/or essential for contributing to the performance ambition<br>- Implement the pre-SESAR changes and the PCP precursors according to Stakeholder roadmaps |
| WSS12 | Interoperability and global harmonisation are not ensured | ATM Master Plan | High | High | EC, SJU | - Work towards global interoperability in the framework of ICAO working arrangements |

| Ref. | Risk description | Type of Risk | Criticality (Dec. 2015) | Criticality (Dec. 2016) | Risk owner | Summary of mitigation/response Actions in 2016 |
|---|---|---|---|---|---|---|
| | | execution | | | | - Continue to strengthen SESAR/NextGen coordination under the EU/US MoC with a particular focus on securing further alignment between the ATM Master Plan and the NextGen Implementation Plan |
| WSS16 | Deployment of SESAR Solutions leads to unaddressed cyber-security vulnerabilities | ATM Master Plan execution | | Medium (New) | EC,SJU | - Ensure efforts on ATM cyber-security are coordinated, and assess policy options for strengthening cyber-security and resilience<br><br>- Establish principles and processes for ensuring cyber-security and resilience appropriately within the work programme |
| WSS17 | Investments to support deployment beyond 2020 is not secured | ATM Master Plan execution | | High | EC,SJU, SDM | - Prepare for the deployment of SESAR R&D results (business cases, impact assessments, future Common projects when appropriate)<br><br>- Ensure that financial and operational incentive mechanism are defined and implemented in a timely manner in order to facilitate the deployment of SESAR<br><br>- Ensure consistency between the stakeholder's roadmaps in the ATM Master Plan and stakeholders' investment plans |
| | SESAR programme does not sufficiently address R&D needs to ensure the integration of all vehicles as identified in the ATM Master Plan (notably GA, rotorcraft and drones) | ADM | | High (New) | EC, SJU | - Include 2017 specific MP update on drones in the MP Ed. 2018 for integration of all types of drones in all classes of airspace<br><br>- Secure appropriate funding for required R&D activities<br><br>- Strengthen cooperation with FAA and NASA on the Very Low drones Operations, also called UTM |

**Table 8: SESAR 2020 programme and Master Plan risk level and mitigation plan summary at 31/12/2016**

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## 1.7  Overall conclusion on the SESAR JU achievements in 2016

In 2016, despite an exceptional workload and outstanding challenges with the combination of 2 programmes to execute in parallel under 2 different regulatory frameworks, the SJU achieved all its objectives. Under these frameworks and in line with the European ATM Master Plan - the main planning tool for ATM modernisation, the SESAR JU and its members and partners have continued to deliver Solutions that are now available for industrialisation activities, and other which are being passed from SESAR 1 to SESAR 2020 for further development and validation.

The SESAR Joint Undertaking has published a first edition of the SESAR Solutions Catalogue, drawing together 61 SESAR Solutions delivered so far by SESAR JU members and partners to modernise Europe's air traffic management system.

Furthermore, in 2016, the SESAR JU started to pave the way for the years to come, with the introduction of multi-annual programming integrating budget and human resources information, materialised in the first edition of the SESAR JU Single Programming Document[22]. In this document, all SJU activities are clustered in 6 Strategic Areas of Operation, which is a structure the SJU will be following from 2017 onwards to ensure overall consistency:

- Strategic Area of Operation 1: Provide Strategic Steering to the SESAR programme
- Strategic Area of Operation 2: Deliver Exploratory Research (ER)
- Strategic Area of Operation 3: Deliver Industrial Research & Validation (IR)
- Strategic Area of Operation 4: Deliver Very Large-Scale Demonstration Activities (VLD)
- Strategic Area of Operation 5: Deliver SESAR Outreach
- Strategic Area of Operation 6: Deliver effective financial, administrative and corporate management

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[22] The first Single Programming Document, covering the period 2017-2019, can be found on the SJU website

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# 2   Part IIa. Management Evaluation

## 2.1   Administrative Board

In 2016, the Administrative Board discussed and approved a standard suite of documents related to the annual programming and reporting cycles (Single programming Document 2017, Consolidated Annual Activity Report 2015, and review of the draft Single Programming Document 2018), specific matters addressed by the Administrative Board in 2016 included, inter alia: the adoption of the SJU anti-fraud strategy (see above in section 1.5.3), the approval of the European ATM Master Plan Level 3, the adoption of the final list of SJU Foreground from 1 January 2014 to 30 June 2015.

The Administrative Board made the following 23 decisions during meetings or through written procedures:

| Subject | Type of decision | Date of adoption |
|---|---|---|
| IAC Work Programme 2016 | Written procedure | |
| Finalisation of the Membership call | Written procedure (restricted) | |
| Annual Work Programme 2015 Amendment n.2 | Written Procedure | |
| SJU Anti-Fraud strategy | Written Procedure | 18.03.2016 |
| Voting rights allocation | ADB(M)-036 | 28.04.2016 |
| Implementing provisions on TAs art 2(f) | ADB(M)-036 | 28.04.2016 |
| Annual Activity Report 2015 and ADB assessment | Written Procedure | 16.06.2016 |
| Update of the Agreement between EUROCONTROL and SESAR Joint Undertaking | Written Procedure (restricted) | 01.08.2016 |
| Final Accounts 2015 and budget results | Written Procedure | 30.06.2016 |
| Annual Work Programme 2016 Amendment n.1 | Written Procedure | 03.10.2016 |
| Budget transfers between Titles and Chapters and Budget 2016 – amendment n.1 | Written Procedure | 30.09.2016 |
| Voting Rights in the Administrative Board | Written Procedure | 23.06.2016 |
| Voting Rights allocation (SESAR 2020 configuration) | ADB(M)037 | 20.10.2016 |

| Subject | Type of decision | Date of adoption |
|---|---|---|
| ADB Rules of Procedure | Written Procedure | 18.10.2016 |
| ATM Master Plan – Level 3 | ADB(M)037[23] | 20.10.2016 |
| Rules of Application of SJU Financial Rules | ADB(M)037 | 20.10.2016 |
| Accounting Officer Appointment | ADB(M)037 | 20.10.2016 |
| ToR Working Groups | Written Procedure | 16.11.2016 |
| Budget 2016 – amendment n. 2 | Written Procedure | 02.12.2016 |
| Final Accounts 2015 | Written Procedure | 08.12.2016 |
| SPD 2017 | ADB(M)038 | 15.12.2016 |
| SESAR 1 Foreground Process (IPRs) | ADB(M)038 | 15.12.2016 |
| Assessment methodology of in-kind contribution | ADB(M)038 | 15.12.2016 |

**Table 9: Administrative Board decisions in 2016**

## 2.2 Major developments

As explained in section 1.5.2 of part I, the Administrative Board membership was renewed in 2016. All CVs and declarations of absence of conflict of interest were collected.

Other governance bodies were renewed.

All new governance system is document in Terms of reference approved by the Administrative Board, one per body.

## 2.3 Budgetary and financial management

### 2.3.1 Budgetary implementation

#### 2.3.1.1 Revenue

Further to the information provided in section 1.5.3.1, the table below provides the breakdown of revenues per revenue sources:

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[23] Subject to EC opinion

| all figures in EUR | 1 | 2 | 3=2/1 | 4 | 5 | 6=5/4 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Type of revenue | Commitment appropriations | Actual Revenues established | % of budget | Payment appropriations | Actual Revenues received | % of budget | Outstanding (from 2016 only) | Outstanding (Total) |
| Contribution from the European Union | 62.138.000 | 51.470.000 | 0,0% | 131.519.225 | 131.519.225 | 100,0% | 0 | 631.594.601 |
| Contribution from Eurocontrol | 22.033.264 | 22.033.264 | 100,0% | 15.134.605 | 0 | 0,0% | 15.134.605 | 49.152.997 |
| Contributions from other Members | 2.345.919 | 2.345.919 | 100,0% | 0 | 0 | 0,0% | 0 | 0 |
| Other sources of contribution and revenue | 3.347.346 | 3.347.346 | 100,0% | 100.000 | 1.293.989 | 1294,0% | 0 | 0 |
| Budget surplus previous year | 9.209.232 | 9.209.232 | 100,0% | 0 | 10.398.808 | 0,0% | 0 | 0 |
| TOTAL REVENUE | 99.073.761 | 88.405.761 | 89,2% | 146.753.830 | 143.212.022 | 97,6% | 15.134.605 | 680.747.598 |

**Table 10: Actual vs. budget revenue in 2016**

### 2.3.1.2 Expenditure

Further to the information provided in section 1.5.3.1, the table below provides the breakdown of expenditures per Title:

| all figures in EUR | 1 | 2 | 3=2/1 | 4 | 5=9+10 | 6=5/4 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Type of expenditure | Final Commitment appropriations | Commitments | % of budget | Payment appropriations | Payments | % of budget | Commitments still to be paid (2016 Carry Forwards only) | Commitments still to be paid (Total) | Payments (against commitments of the year) | Payments (against previous years' commitments) |
| | | | | Budget 2016 | | | | | | |
| Staff Expenditure | 6.191.500 | 6.172.482 | 99,7% | 6.191.500 | 5.018.626 | 81,1% | 605.563 | 605.563 | 4.895.105 | 123.520 |
| Administrative Expenditure | 4.058.500 | 3.666.907 | 90,4% | 4.058.500 | 2.711.600 | 66,8% | 2.545.817 | 2.545.817 | 1.121.091 | 1.590.510 |
| Operating Expenditure | 88.823.761 | 87.274.264 | 98,3% | 146.902.638 | 95.243.002 | 64,8% | 80.592.986 | 237.039.821 | 6.681.278 | 88.561.724 |
| *1. Studies/Development conducted by the SJU* | 88.823.761 | 87.274.264 | 98,3% | 54.545.297 | 37.667.428 | 69,1% | 80.592.986 | 123.176.624 | 6.681.278 | 30.986.149 |
| *2. Studies/Development conducted by Eurocontrol* | 0 | | | 0 | | | 0 | 0 | 0 | 0 |
| *3. Studies/Development conducted by other Members* | 0 | 0 | | 92.357.341 | 57.575.574 | 62,3% | 0 | 113.863.197 | 0 | 57.575.574 |
| TOTAL EXPENDITURE | 99.073.761 | 97.113.654 | 98,0% | 157.152.638 | 102.973.228 | 65,5% | 83.744.365 | 240.191.201 | 12.697.474 | 90.275.754 |
| TOTAL REVENUE | | | | | 156.866.396 | | | | | |
| BUDGET RESULTS | | | | | 53.893.168 | | | | | |

**Table 11: Actual vs. budget expenditure in 2016**

## 2.3.2 In-Kind contributions

### 2.3.2.1 In Kind Revenue (SESAR 1 only – Annex I of the Budget)

| all figures in EUR | 1 | 2 | 3=2/1 |
|---|---|---|---|
| **Type of revenue** | **Commitment appropriations** | **Actual Revenues established** | _**%of budget**_ |
| Contribution from the European Union | 0 | 0 | |
| Contribution from Eurocontrol to be recognized | 63.835.000 | 49.224.787 | _77,1%_ |
| Contributions from other Members to be recognized | 0 | 0 | |
| Other sources of contribution and revenue | 0 | 0 | |
| Budget surplus previous year | 0 | 0 | |
| **TOTAL REVENUE** | **63.835.000** | **49.224.787** | _77,1%_ |

Table 12: In-kind revenues in 2016

### 2.3.2.2 In-Kind Expenses (SESAR 1 only – Annex I of the Budget)

| all figures in EUR | 1 | 2 | 3=2/1 |
|---|---|---|---|
| **Type of expenditure** | **Commitment appropriations (Final budget)** | **Actual Commitments** | _**%of budget**_ |
| Staff Expenditure | 0 | 0 | |
| Administrative Expenditure* | 0 | | |
| Operating Expenditure | 63.835.000 | 49.224.787 | _77,1%_ |
| _1. Studies/Development conducted by the SJU**_ | _0_ | | |
| _2. Studies/Development conducted by Eurocontrol**_ | _63.835.000_ | _49.224.787_ | _77,1%_ |
| _3. Studies/Development conducted by other Members_ | _0_ | _0_ | |
| **TOTAL EXPENDITURE** | **63.835.000** | **49.224.787** | _77,1%_ |
| **TOTAL REVENUE** | | **49.224.787** | |
| _**BUDGET SURPLUS**_ | | **0** | |

Table 13: In-kind expenditure in 2016

### 2.3.3   Budget Outturn

As introduced in section 1.5.3.1, the Budget Outturn for 2016 amounts to EUR 40.237.981, composed of EUR 33 638 248 for SESAR 1 and EUR 6.599.732 for SESAR 2020. The 2016 surplus that remains within the Joint Undertaking amounts to EUR 37.043.018 (EUR 40.237.981 gross payment surplus minus EUR 3.194.962 carry-over for Titles I & II). The table below presents these figures in detail:

| *all figures in EUR* | 2016 | 2015 |
|---|---|---|
| **REVENUE RECEIVED FOR THE YEAR** | | |
| Contribution from the European Union SESAR1 | 75.000.000 | 82.582.275 |
| Contribution from the European Union SESAR2020 | 56.519.225 | |
| Contribution from Eurocontrol | | 14.859.510 |
| Contributions from other Members | 0 | 4.246.362 |
| Other sources of contribution and revenue | 1.293.176 | 50.031 |
| **TOTAL REVENUE (1)** | **132.812.401** | **101.738.178** |
| | | |
| **TOTAL PAYMENTS MADE FOR THE YEAR** | | |
| Staff Expenditure SESAR1 | (5.018.626) | (4.927.129) |
| Administrative Expenditure SESAR1 | (2.711.600) | (2.446.657) |
| Operating Expenditure SESAR1 | (45.323.509) | (105.402.187) |
| Operating Expenditure SESAR2020 | (49.919.493) | |
| **TOTAL EXPENDITURE (2)** | **(102.973.227,86)** | **(112.775.973,00)** |
| | | |
| ***BUDGET SURPLUS of the year (3)=(1)-(2) SESAR1*** | *23.239.440* | *(11.037.795)* |
| ***BUDGET SURPLUS of the year (3)=(1)-(2) SESAR2020*** | *6.599.732* | *0* |
| | | |
| **Total Budget Surplus previous year (4) SESAR1** | **10.398.808** | **21.436.603** |
| **Total Budget Surplus previous year (4) SESAR2020** | **0** | |
| ***NEW TOTAL BUDGET SURPLUS (5)=(3)+(4) SESAR1*** | *33.638.248* | *10.398.808* |
| ***NEW TOTAL BUDGET SURPLUS (5)=(3)+(4) SESAR2020*** | *6.599.732* | *0* |
| | | |
| **COMMITMENTS STILL TO BE PAID (6)** | | |
| ***(Carry Forwards from year Title 1&2 only) SESAR1*** | *(3.194.962)* | *(3.027.976)* |
| | | |
| **TOTAL BUDGET OUTTURN (7)=(5)+(6) SESAR1** | **30.443.286** | **7.370.832** |
| **TOTAL BUDGET OUTTURN (7)=(5)+(6) SESAR2020** | **6.599.732** | **0** |

**Table 14: Budget Outturn for 2016**

### 2.3.4 Budget implementation allocation per Area of Operation

The figures below indicate the budget allocation per Area of Operation:

**Budget implementation 2016 (Commitments) allocated per Area of operation**
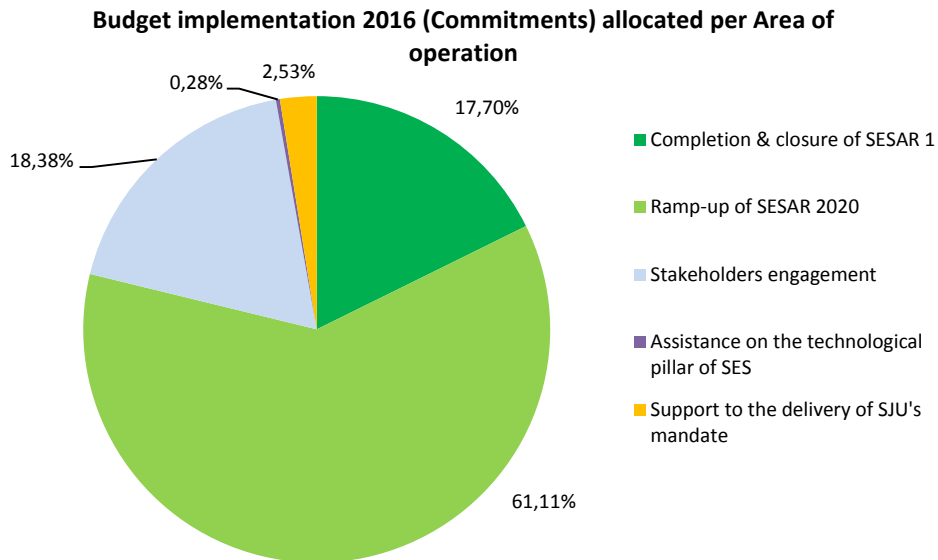


**Figure 8: The 2016 Budget allocation per Area of Operation (Commitments)**

**Budget implementation 2016 (Payments) allocated per Area of operation**
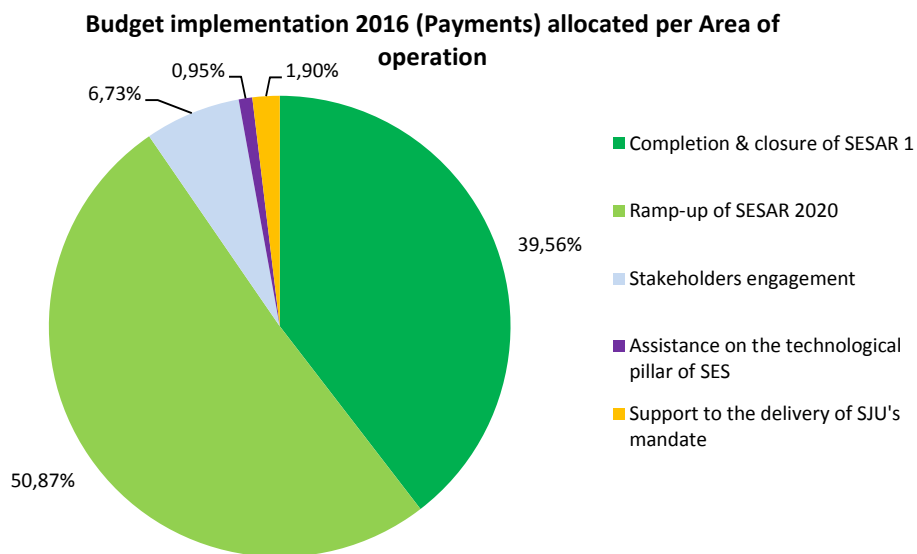


**Figure 9: The 2016 Budget allocation per Area of Operation (Payments)**

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## 2.4   Human Resources management

Main activities in the field of HR are explained in section 1.5.3.2.

The Staff Establishment Plan appears in Annex IV. Based on this Staff Establishment Plan (and including in addition 3 Seconded National Experts), at the end of 2016 the benchmarking result is the following.

| Job Type (sub) category | 2015 (%) | 2016 (%) |
|---|---|---|
| *Administrative Support and Coordination* | *29%* | *30%* |
| Administrative Support | 17% | 16% |
| Coordination | 12% | 14% |
| *Operational* | *64%* | *62%* |
| General operational | 32% | 30% |
| Programme management | 18% | 18% |
| Top-level operational coordination | 11% | 10% |
| Evaluation & Impact assessment | 4% | 4% |
| *Neutral* | *7%* | *8%* |
| Finance and Control | 7% | 8% |
| Lingustics | 0% | 0% |

**Table 15: Benchmarking on Human Resources**

The slight difference observed for job type categories 'Administrative Support & Coordination' and 'Neutral' is explained by the temporary staff increase of 2 Contract Agents (Function Group IV) in order to reinforce the resources in the Financial and in the Legal and Procurement Sectors, during the 2016 and 2017 exercises. This temporary staff increase was defined in the SPD 2017.

The allocation of human resources per Area of Operation appears in the following figure:

**FTE allocation (2016) per Area of Operation**
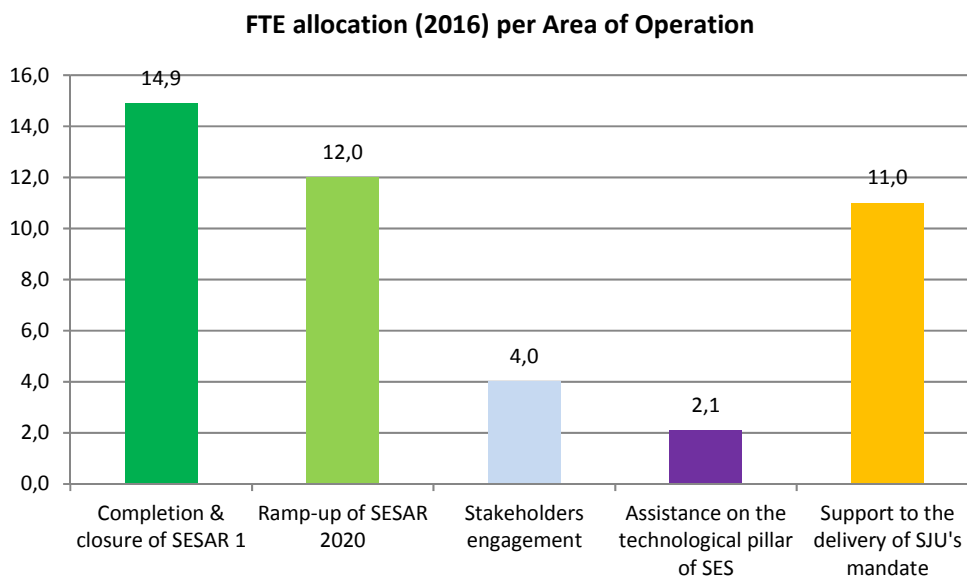


**Figure 10: Human resources allocation per Area of Operation**

## 2.5 Assessment by Management

Based on the procedures performed by staff of the SJU, a **positive conclusion on the effectiveness, legality and regularity of transactions** can be drawn.

This conclusion takes into consideration the following factors:

**Overall Budget Implementation Rate**

As a result of year budget monitoring throughout the year, budget implementation rate is at 89,2% for revenue commitment appropriations and at 98% for expenditure commitment appropriations.

**Legality and regularity**

Based on the control procedures performed by staff of the SJU, a positive conclusion on the legality and regularity of transactions can be drawn. This conclusion takes into consideration the need for SJU to maintain a high level of efficiency of its internal control environment and to constantly assess and strengthen the existing controls in order to maintain compliance with the requirements of the 16 ICSs adopted and to ensure the achievement of objectives in its annual work plan.

In order to ensure the sound financial management, legality and regularity of the underlying transactions, all transactions are submitted to the four eyes principle in the preparation phase as well as in the payment phase. The ex-ante control function is exercised at operational level, to verify the work performed during the initiation of the transaction to ensure that the required results are achieved, and at financial level to verify the application of the rules.

The extensive ex-ante controls allowed for avoidance of material errors and formal errors, detected at different levels of the authorisation process (initiation, verification, authorization and payment).

**Procurement procedures**

Six  procedures were run and all completed in 2016. More details can be found in section 1.5.3.3 and Annex I.3.

**Registration of exceptions**

The SJU has established an "exceptions' register" to manage and monitor possible exceptions to rules, and all exceptions are submitted to the AO with a justification for endorsement. So far no exceptions of material value have been recorded.

**Audit results and recommendations**

In 2016, no critical recommendations were issued as a result from audits, and recommendations from previous years have been worked upon.

This is presented in sections 2.7 and 2.8.

*Although substantial progress has been achieved, the SJU's staff is committed to continue its efforts to reach the highest standards for management and control systems.*

## 2.6    Budget implementation tasks entrusted to other services and entities

This section is not applicable for the SESAR JU in 2016.

## 2.7    Assessment of audit results during the reporting year

### 2.7.1    Internal Audit Service (IAS)

In October 2015 the IAS performed an audit on "Operational governance and Master Plan update". The SJU received the final report in February 2016. This audit report led to 2 'very important' and 1 'important' recommendation which were all accepted by the SJU. The SJU set up an action plan related to these recommendations, which was approved by the IAS in April 2016. An overview of these recommendations and the status of implementation can be found below.

| n° | Recommendation | Priority | Status |
|---|---|---|---|
| IAS audit on operational governance and Master Plan update (2015) | | | |
| 1 | Reinforce the Master Plan update and reporting | Very Important | Expected to be implemented in 2017 No significant delays observed |
| 2 | Improve coordination with the Deployment Manager with regard to Level 3 monitoring and reporting | Very important | |
| 3 | Appointment of the new SJU's working groups | Important | |

**Table 16: Status of IAS audits recommendations in 2015-2016**

In October 2016, the IAS performed an audit on H2020 processes. This audit assessed the SJU's compliance to H2020 processes, namely with regards to topic identification, the evaluation and selection of proposals and the preparation of the grant agreements.

The final report is expected in March 2017.

### 2.7.2    Internal Audit Capability (IAC)

In 2016, the IAC issued a report on the Validation of ABAC Workflow authorisations which led to no major recommendations.

Furthermore, the activity of the IAC in 2016 focused on fraud prevention training and guidance for staff, liaising with relevant audit actors relating to the various ongoing audits, consulting missions and ad-hoc advice on efficient and effective management to SJU management.

### 2.7.3    European Court of Auditors (ECA)

In October 2016, the European Court of Auditors issued their final report on the annual accounts of the SESAR Joint Undertaking for the financial year 2015. The report concluded that the Joint Undertaking's annual accounts present fairly, in all material respects, its financial position as at 31 December 2015 and the results of its operations and its cash flows for the year then ended, in accordance with the provisions of its financial rules and the accounting rules adopted by the Commission's accounting officer. Additionally, in the Court's opinion, the transactions underlying the

annual accounts for the year ended 31 December 2015 were, in all material respects, legal and regular.

Additionally, in 2016, the European Court of Auditors launched a Performance audit of the Single European Sky evaluating the outcome and value for money of the SES. The audit scope comprises 3 components: construction of the SES, regulatory components and SESAR. The auditors sampled 16 SESAR projects which were audited in 5 different countries. Furthermore various stakeholders were involved such as National Supervisory Authorities, ANSPs, Political level, User community and SESAR users. The final report is expected by June 2017.

The European Court of Auditors also ran the audit of the 2016 Annual Accounts of the SJU. Fieldwork is concluded, but the preliminary observations have not been concluded yet at the time of drafting the present report.

## 2.8   Follow-up of recommendations and action plans for audits

During 2016, no critical recommendations were issued or closed and on 31 January 2017, no critical recommendations were still open.

On 31 January 2017, the following two very important recommendations related to the Audit on Risk Management (final report in September 2014) were still open and overdue by at least six months[24]:

| n° | Recommendation | Priority | Status |
|---|---|---|---|
| IAS audit on Risk Management  (2014) | | | |
| 1 | Efficiency of the bottom-up approach | Very Important | In agreement with the IAS, deadlines were extended in order to align implementation to H2020 processes. Implementation is expected  in 2017 |
| 2 | Supervision / monitoring of the risk management process (bottom-up approach) | Very important | |
| 3 | Linking risks to objectives at SJU level | Important | |

**Table 17: Status of IAS audits recommendations in previous years**

The SJU intends to implement the action plan related to both overdue recommendations in 2017.

Recommendation N° 1: "Efficiency of the bottom-up approach"

Unaddressed Risk: The IAS noted the complexity of the design of the bottom-up risk management approach (at project and Work Package level) and identified inconsistencies and quality issues in its implementation. Below are the risks identified during the audit, which remain unaddressed due to the delay in implementation of the IAS recommendation:

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[24] IAS Report on critical and significantly delayed very important IAS recommendations 2016  Under Article 82 (6) of the 2013 Framework Financial Regulation (report dated on  9 March 2017)

- Disproportionate requirements entail the risk of being perceived as unnecessarily burdensome, rather discouraging than engaging all actors.
- In employing a very complex Risk Management SJU carries the risk of employing its own resources as well as those of the Programme members' in a sub-optimal way.
- The RIO register might not unfold its full added value if core features enabling a more efficient monitoring of the Risk Management information are lacking.

The implementation of the Action Plan was originally due by 31/03/2016 but has been revised to the target date 31/03/2017. The delay was due to the alignment of the action plan with H2020 rules.

Recommendation N° 2: Supervision / monitoring and reporting of the RIO Management process (bottom-up approach)

Unaddressed Risks:

- The lack of supervision and harmonized implementation of the methodology used by projects in the identification, assessment and assignment of significant risks may prevent the comparison between projects, result in unreliable information presented to management for decision-making, and prevent their efficient and effective management.
- Inadequate monitoring may hinder management to take corrective or mitigating actions which may cause delays and jeopardise the achievement of objectives.
- The lack of informative KPIs regarding highly critical areas may lead to an incomplete or inaccurate overview of the results of the bottom up management process.

The implementation of the Action Plan was originally due by 31/03/2016 but has been revised to the target date of 31/03/2017. The delay was due to the alignment of the action plan with H2020 rules.

Furthermore, the state of play of the actions taken on IAS and IAC recommendations from previous years appears in annex VI.2.

## 2.9   Follow-up of observations from the discharge authority

In May 2016, the European Parliament granted discharge to the SJU regarding the financial year 2014. In its resolution (2015/2197(DEC)) the European Parliament made observations regarding the implementation of the budget for the financial year 2014, notably on Budget and financial management, Calls for proposals, the implementation status of SESAR's projects (level of payments, payments plans for the next years), Risk Management and the Role of the JU. These were all acknowledged and confirmed by the SJU and a written reply was addressed to the European Parliament in this respect[25].

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[25] Letter of the Executive Director with reference SJU D-16/910

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Founding Members

# 3   Part IIb. External Evaluations

In 2016, the SJU was subject to the interim evaluation of the JUs operating under Horizon 2020, launched by the EC. This evaluation assesses inter alia openness to newcomers, transparency, inclusiveness of a wide community of stakeholders, easy and effective access to information, European added value and leverage effects.

The final report is expected in June 2017.

Additionally, the EC launched the Interim Evaluation of the SJU. In this evaluation the SJU is evaluated on operational effectiveness and efficiency, achievements of KPI's, scientific output and socio-economic impact.

The final report is expected in June 2017.

Founding Members

# 4 Part III. Assessment of the effectiveness of the internal control systems

## 4.1 Risk Management

Major corporate risks (called 'critical') are reported in section 1.6 of part I of this document.

Within the context of the overall internal control framework described below, throughout 2016 the SJU reviewed, managed and mitigated corporate and R&D risks through the adoption of a multi-faceted approach. This comprised regular and detailed discussions at management level, the maintenance of a corporate risk register and dedicated action plans and mitigation measures designed to address identified risks. Concretely, the SJU undertakes an annual risk review exercise covering the JU's operational and administrative activity areas with the aim of identifying possible critical risks, assessing their likelihood and impact on SJU's operations and objectives and determining the response in order to mitigate/reduce/eliminate them to the extent feasible.

In 2016, the following process was followed to identify and monitor SJU risks:

- In January 2016, a questionnaire was sent to all SJU staff  with a large set of questions on risks and associated actions: it served as a major input for Corporate risk management workshop held in March 2016;
- On March 14th, 2016, a Corporate risk management workshop  was organised with the objective to perform a thorough review of the list of risks maintained over the past years: as a result,
    - o 2 new risks were identified and action plans defined,
    - o 13 risks were closed because they were considered not relevant anymore due to effective actions, or because they are now embedded in other risks;
- During the summer, a review of mitigation actions associated to the updated list of risks was conducted, as the main input for the second Corporate risk management;
- The second Corporate risk management took place on October 3rd, with the objectives to
    - o present the status of the mitigation actions associated to the open risks and update the risk register accordingly. This resulted in
        - 3 risks seeing their criticality decreased from High to Medium,
        - 1 risk closed as embedded in an existing one,
        - 2 new risks identified and assessed of which 1 with high criticality (safe integration of all vehicles not sufficiently addressed in the R&I programme compared to MPL1 requirements) and action plan was defined;
    - o give a state of play regarding recommendations from the audit (see section 2.8); 1 of the recommendations from the audit was closed (linking risks to objectives);
    - o trigger the update of the risk policy to embed audit recommendations and include changes linked to new SESAR 2020 framework; guidelines supporting the update of the risk policy were agreed upon;
- After the workshop, the risk management team took the following initiatives:
    - o Feedback to staff: the Risk Management Coordinator sent an email to all staff providing the status of risks and related mitigation actions,
    - o Outcomes of the WS were incorporated in the SPD 2017,

- o Activities to update the risk policy were launched;

- Lastly, concluding this process, in December 2016, the management team formally reviewed the entire risk register composed of 31 risks and 83 related mitigation actions. The risks which were considered to have both a high probability of occurrence and a potential significant impact on the Joint Undertaking achieving its objectives as well as impacting Master Plan execution were identified and mitigation actions were planned. In addition, a broader review of the risks and actions related to the MP execution has been made with the contribution of all stakeholders in the context of the Master Plan update campaign.

## 4.2 Compliance and effectiveness of Internal Control Standards

The Management Team is reviewing the Internal Control Standards on a yearly basis, by assessing each of the 35 requirements composing the 16 Standards[26], materialised with a rating (3 = full compliance; 2 = partial compliance requiring improvement; 1 = non-compliance requiring action plan). This assessment leads to the definition of action plans, where required.

At end 2016, the assessment of the Internal Control Standards by the SJU management is the following:

**Assessment of the Internal Control Standards at end 2016**



Figure 11: ICS assessment by SJU Management team at end 2016

As is shown in the figure, the SJU fully complies with 10 Standards and partly with 6 others. No non-compliance is identified. For the 8 Standards where partial compliance is identified, the following

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[26] As per the Internal Control Standards framework updated in 2014

action plan is defined (and is reflected, where relevant, in the Single Programming Document for 2017:

- **ICS1 Mission** – The SJU has up-to-date mission statements and management aims to update the internal organisation note to increase the understanding of the organisational values (target date: May 2017);
- **ICS7 Operational Structure** – The SJU does not have an IT master plan: the ICT infrastructure is outsourced and the SJU makes use of EC/H2020 IT tools as far as available. A project is planned to be put in place in 2017 on Information and Document Management, which will amongst other deliver an IT architecture;
- **ICS9 Management Supervision** – The supervision of operational performance is based on the SPD objectives. The reference to useful performance indicators has been identified as an area of improvement to be dealt by with in 2017;
- **ICS10 Business Continuity** – Due to the size of the organisation, its objectives, its priorities, the SJU staff currently does not attend training related to BCP and the BCP is not reviewed yearly;
- **ICS11 Document Management** – A Document Management System currently exists but a more capable DMS tool is being developed with the target to be delivered in 2017. Although a filing system, as described in the ICS Requirement R23 is not in place in the SJU, documents containing confidential and personal information are only available to relevant staff and data protection policy is in place;
- **ICS12 Information and Communication** – The SJU has a data management system, but is working on further improving it in the context of the IDMS project (see above);

A complete report on the assessment of the 16 Standards is available in annex VII.

## 4.3   Project Audits

As introduced in the Annual Work Programme for 2016, one of the major pillars of assurance for SJU is its ex-post audit activity and as such it represents a significant element of the Internal Control System. Its main objectives are to:

- Assess the legality and regularity of the validation of cost claims performed by SJU's management;
- Provide an adequate indication on the effectiveness of related ex-ante controls;
- Provide the basis for corrective and recovery activities, if necessary.

On the basis of the ex-post audit strategy, as adopted by the SJU Administrative Board, 21 audit exercises were scheduled and several remaining audits from previous reporting periods were finalised. During the year 2016, 21 audits have been planned in five Selected Members and 14 of these audits have been finalised. The remaining 7 are in the pre-final stage and are expected to be finalised in the first quarter of 2017. However, because of the fact that the findings of the non-closed audits are not expected to be challenged during the contradictory procedure, we have taken into account their audit findings for the purpose of calculating the error rates.

### 4.3.1 Overview

The total amounts of Costs declared in the Interim financial Statements 2014 (IFS 2014) by all 15 Members (excluding EUROCONTROL) of the SJU amounted to EUR 168.000.000.

The audits performed in 2016 complemented the third cycle of audits in all 15 Members as described in the SJU Ex-Post Audit Strategy (as approved by the ADB-15-2010, replaced by the ADB-15-2013 and revised by ADB 12-2015). Based on the methodology described in the SJU Ex-post audit strategy, Batch 6 was composed of the 5 Members that were audited during the third cycle of audits in Batch 3 and it was reinforced by follow-up audits of CBFs of previous periods in order to ensure that after the first audit, errors have been corrected, recommendations have been implemented and therefore the IFSs of previous periods are free from systematic errors and material misstatements. The audits confirmed that this was the case in 7 out of 13 audited entities.

### 4.3.2 Coverage

The Interim Financial Statements received by all 5 Members (that were included in Batch 6) – EUR 168 million– were examined at the level of Projects; 126 CBFs were selected, representing EUR 16,2 million (i.e. 10% of the IFSs of the 15 Selected Members and 56% of total costs accepted for the 5 Members).

Based on the work performed and after the adjustments made by the concerned Members as a result of the findings of the audit work, the Project Audit function is of the opinion that

1. the cost claims submitted for the IFS2014 of the audited Members, are not any longer affected by systematic errors, and
2. nothing appeared to the attention of the auditors concerning the respect of the principles of regularity and legality of the underlying expenditure and sound financial management.

Furthermore, the Members audited in the course of 2016 demonstrated their willingness to adopt the Project Audit Reports' recommendations to avoid in the future similar mistakes to those detected.

### 4.3.3 Results

#### 4.3.3.1 Representative Error Rate

Based on 126 cost statements for which the audit is completed (or almost completed as no changes are expected during the contradictory procedure), the results of the finalised audits indicate a representative error rate of 7,25%.

Where systematic errors are detected, audited Members are requested to take immediate actions to correct them and implement recommendations made by the auditors in the audit reports. The errors found mainly concerned the incorrect calculation of labour costs, by using wrong number of productive hours or inclusion of ineligible items in the pool of indirect costs. The amounts to be recovered from the Members were identified and will be recovered from the co-financing to be paid for the IFS 2016.

#### 4.3.3.2 Residual Error Rate

The residual error, defined as the error remaining in the population after the corrections and recoveries are made, for the year 2016 was calculated to 6,21%. This year's annual error appears to

be above 2% because there were audits performed in entities of a Member that have never been audited in the past either by the SJU or any other European Commission Service; therefore these entities were not fully aware of the FP7 and TEN-T rules of eligibility of costs. As this figure results from the sample audits of only 5 out of 15 Members (in compliance with the SJU Ex-Post Audit Strategy), it cannot be considered a representative value for the entire Programme's residual error.

### 4.3.3.3    Cumulative Error Rates

Given the multiannual nature of the Programme which is considered to be closed per Member at the last deliverable accepted within the Programme (i.e. in 2016), the cumulative error rate of the previous years gives the global and representative view of the error on the entire population of the SJU. For this calculation the following factors are taken into account: (1) the method is based on the assumptions that representative errors are corrected and recovered, therefore the costs claimed by a Member the periods subsequent of an audit are assumed to be free from error and material misstatements and (2) the residual error is assumed to be affecting all the non-audited cost claims of previous and subsequent un-audited periods.

Based on a total amount of costs claimed of EUR 728,8 million, of which 383 cost statements were audited representing all 15 Members amounting to EUR 77 million of (i.e. 10%), after the 2016 audit exercise the new representative error rate is 6,07% and the **new residual error rate is 1,34%**.

### 4.3.3.4    Implementation of audit results

The following table presents an overview of the implementation of the audits which resulted in an adjustment at cost level in favour of the SJU. The adjustments are mainly recovered through offsetting against subsequent payments. For 2016 recovery orders will be issued and netting off will be done with payment of IFS2016.

### 4.3.3.5    Extension of audit findings

The extension of audit findings is an on-going procedure, which stems from systematic errors identified in audited participations of a Member and subsequently corrections of the non-audited participations of the same Member are required, with the submission of the corrected cost claims in the subsequent reporting period.

(Tables with details on 2016 implemented cases will be provided in the final version of this document.)

### 4.3.3.6    Risk-based audits

No risk-based audit was performed during 2016.

### 4.3.3.7    Performance audit

No performance audit was conducted in 2016.

### 4.3.3.8    Desk Control

One of the representative audits of Batch 4 was transformed to Desk Control because of the fact that the Member is based in Melbourne-Australia. The control is currently on-going and is expected to be finalised in the first semester of 2017.

### 4.3.3.9    Other budget lines

No contracts have been audited on other budget lines.

### 4.3.3.10 Resources

During 2016, 12 audits were performed by E&Y and 9 audits were carried out by PKF, because of an identified conflict of interest of the Member with Ernst & Young (statutory auditor).

The resources devoted to the audits outsourced and those done by the SJU are shown in the table below.

| Resources devoted to audits in 2016 | | |
|---|---|---|
| Year | 2015 | 2016 |
| Internal Resources EPA (FTE) | 1 | 1 |
| Cost of outsourced auditing (in EUR) | 465.000,00 | 457.000,00 |

The SJU also has a revised framework contract in place for audit services with three external audit firms. The audit activity is performed solely by those firms. No material issue has been identified in the audits performed to date that would require the attention of the Administrative Board.

# 5   Part IV. Management assurance

## 5.1   Review of the elements supporting assurance

The aim of this section is to provide information on the current set of 'building blocks' that enable the Executive Director to obtain a full picture of the state of play of the SJU, underpinning the reasonable assurance given by the Authorising Officer in his declaration of assurance of the Annual Activity Report and allowing him to give adequate assurance to the Management Board.

These building blocks are composed of the following elements:

*Building block 1 – Assessment by management:*

This assessment is provided in section 2.5.

*Building block 2 – Register of exceptions:*

The SJU has had a procedure in place since 2009 for registering exceptions. Its overall objective is to establish appropriate arrangements to ensure that any exceptional circumstance of significant instances of overriding controls or deviations from the established regulatory framework is well explained, registered and reported in accordance with the principle of transparency. An exception must be documented, justified and approved at the appropriate level before any action is taken.

In 2016, no deviation and/or exception from the established procedures were registered (see Annex VI.1).

*Building block 3 – Audit results during the reporting period:*

Audit results and recommendations are presented in sections 2.7, 2.8 and 2.9.

## 5.2   Reservations

No reservation can be made on the SJU's activities in 2016.

## 5.3   Overall conclusions on assurance

No qualification is to be made on SESAR JU's activities.

There are also no reservations on the procedures relating to the selection of participants for SESAR 2020 projects in 2015 and the corresponding underlying financial operations (legal and financial commitments). This is also the case for SJU payments relating to administration and procurement.

On the basis of the above elements, the Management provides a reasonable assurance that all necessary control procedures are in place to guarantee the legality and regularity of the SJU's activities, in line with the principles of economy, efficiency and effectiveness.

Approved

# 6 Part V. Declaration of Assurance

I, the undersigned, Executive Director of the SESAR Joint Undertaking,

In my capacity as Authorising Officer,

Declare that the information contained in this report gives a true and fair view.

State that I have reasonable assurance that the resources assigned to the activities described in this report have been used for their intended purpose and in accordance with the principles of sound financial management, and that the control procedures put in place give the necessary guarantees concerning the legality and regularity of the underlying transactions.

This reasonable assurance is based on my own judgement and on the information at my disposal, such as the results of the self-assessment, ex-post controls, the work of the Internal Audit Service, [the work of the Internal Audit Capability and the lessons learnt from the reports of the Court of Auditors for years prior to the year of this declaration.

Confirm that I am not aware of anything not reported here which could harm the interests of the agency.

Brussels, 28 June 2017

Signature

Florian Guillermet

Executive Director

SESAR Joint Undertaking

Approved

# 7 Annexes

## Annex I. Core business statistics

In this annex, we provide further detail on the information which is provided in Part I of this document.

### Annex I.1       SESAR 1

### Annex I.1.1       Work Packages update – activities and delivery in 2016

*WP 3 – Validation Infrastructure Adaptation and Integration*
**Scope:**

The scope of WP3 is defined by the evolution of required Industry-Based/Pre-Operational Verification and Validation Platforms to include simulation, shadow mode and/or live trials capabilities. Combined with the connection/integration of the necessary test tools, this allows these platforms to be used for verification and validation activities.

WP3 also has the responsibility of SESAR Verification and Validation Infrastructure (V&VI) that includes the set of preparation/analysis tools, Validation and Verification facilities and test equipment.

**Objectives:**

The objective of WP3 is 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.

**Main activities conducted in 2016:**

WP3 continued to support SJU in the analysis of completeness, correctness and coherency of the Verification and Validation (V&V) data. In the context of Release 5, WP3 led successfully the System Engineering Review 2 following the validation exercises life cycle.

For validation exercises (either R5 or no-release exercises), WP3 continued to support operational, system and transversal projects at different stages of the validation chain by:

- capturing V&V needs,
- supporting the development and/or the adaptation of the Validation Industrial Platforms (IBPs), the V&VI infrastructure and the measurement tools,
- integrating the prototypes made available by the primary system projects into the IBPs, doing their technical acceptance in order to ensure their readiness for validation exercise execution.

WP3 has established recognised system engineering and information methodology within the programme for all aspects linked to the V&V Platforms evolution, including its verification. The steadily increasing number of projects requesting for WP3 support for their validation activities confirms this.

*WP 4 – En-Route Operations*

**Scope:**

The scope of Work Package 4 is to provide the operational concept description for the En- Route Operations and perform its validation. The term "En-Route" includes both 'continental' and 'oceanic' applications. The applications of 4D and performance-based operations are also seen as a cornerstone of future en-route operations.

**Objectives:**

The objectives of WP4 are to:

- Develop, refine and update the En Route concept, based upon the SESAR CONOPS and ensure consistency with other elements of the work programme;
- Define and perform the necessary validation activities including operability, safety & performance assessment at all levels;
- Demonstrate the operational feasibility of the En Route Operations concept in a complete ATM environment (including systems) in order to:
  - o 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);
  - o Improve the ground safety nets functionalities considering the proposed operational functionalities such as used of Downlink Aircraft Parameters, or the improved air-ground collaboration;
  - o Improve the airborne safety nets in order to reduce false alerts and to consider latest evolutions.

These objectives are being achieved through a portfolio of 16 R&I projects.

**Main activities conducted in 2016:**

The concept activity has been consolidated with the one of the other domains under the umbrella of B04.02 to produce a first draft of the TRANSITION CONOPS S2020; the development of the supporting TRANSITION S2020 Validation Strategy has been done under the leadership of Project 05.02.

The major focus has been on the Business Trajectory with the delivery of the first Interoperability document and major progress on the associated validation activity; as one of the SESAR pillars the Programme Committee has been working on a new approach to secure the development of the Business Trajectory till the end of the Programme. It is to be noted that FREE ROUTE operations solutions have also matured at V2 level, while full validation of PBN SESAR Solution for PCP has been performed.

Safety nets are reinforced with the development of a technical solution to downlink resolution advisories and with the definition of European needs & acceptability criteria for ACAS Xa (in close collaboration with the FAA and EUROCAE). Projects dedicated to mid-term conflicts management have achieved key results through V3 validation of innovative Tactical Controllers Tools for evolutive traffic.

### WP 5 – TMA Operations

**Scope:**

Work Package 5 manages and performs all Research, Development and Validation activities required to define 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.

**Objectives:**

The objectives of WP5 are to:

- Refine the concept definition at TMA operational context level and for co-ordinating and consolidating the various projects and sub work packages that encompasses Terminal Airspace Operations;
- Define and perform the necessary validation activities including operability, safety & performance assessment at all levels;
- Demonstrate the operational feasibility of the TMA Operations concept in a complete ATM environment (including systems);
- Consider the potential for operational trials and the early introduction of SESAR Concepts in a TMA environment;
- Develop, refine and update the TMA concept, based upon the SESAR CONOPS and ensure consistency with other elements of the work programme;
- Define and perform the necessary validation activities including operability, safety & performance assessment at all levels;
- 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 improve 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

**Main activities conducted in 2016:**

The TRANSITION CONOPS S2020 has been consolidated with B04.02 while the supporting TRANSITION S2020 Validation Strategy has been finalised under the leadership of Project 05.02.

All remaining active projects were closed in 2016 contributing to the delivery of five SESAR Solution in Release 5 as part of the Advanced air traffic services Key Feature: Arrival Management into Multiple Airports (Solution #8), Continuous Descent Operations (CDO) (Solution#11), ASAS Spacing applications Remain behind and Merge behind (Solution #16), Controlled Time of Arrival (CTA) in Medium density / medium complexity environment (Solution#06). Projects were also involved in the development and validation of Initial ground-ground interoperability (Solution #28).

## WP 6 – Airport Operations

**Scope:**

The Airport Operations Work Package addresses 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.

**Objectives:**

The objectives of WP06 are to:

- Develop, refine and update the Airport Operations concept, based upon the SESAR CONOPS and ensure consistency with other elements of the work programme;
- 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.

**Main activities conducted in 2016:**

2016 saw the finalisation of the operational concept and the execution of the last validation activities in the Work Package. Most of the operational concepts under development in WP06 reached a final V3 maturity level.

WP06 delivered eleven SESAR Solutions in Release 5 as part of the high-performing airport operations Key Feature: Runway status lights (Solution #01), Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances (Solution #02 – PCP related), Enhanced traffic situational awareness and airport safety nets for vehicle drivers (Solution #04), Single remote tower operations for medium traffic volumes (Solution #12), Remotely-provided air traffic services for contingency situations at aerodromes (Solution #13), Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP) (Solution #21 – PCP related), Automated assistance to controllers for surface movement planning and routing (Solution #22 – PCP related), D-TAXI service for controller-pilot datalink communications (CPDLC) application (Solution #23), Guidance assistance through airfield ground lighting (Solution #47), Virtual block control in low-visibility procedures (Solution #48) and De-icing management tool (Solution #116).

WP06 also contributed to the delivery of the following SESAR Solutions in Release 5 by supporting their development and validation with airport expertise: Enhanced terminal operations with RNP

transition to ILS/GLS (Solution #09 – PCP related), Calculated take-off time (CTOT) and target time of arrival (TTA) (Solution #18 – PCP related), Initial collaborative network operations plan (NOP) (Solution #20), Initial ground-ground interoperability (Solution #28) and Meteorological information exchange (Solution #35 – PCP related).

*WPs 7 & 13 – Network Operations*

**Scope:**

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.

**Objectives:**

The objectives of the Network Operations Work Package are to:

- Develop, refine and update the Network Operations concept and architecture, based upon the SESAR CONOPS and ensure consistency with other elements of the work programme;
- Develop 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;
- Develop 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);
- Define and develop the User Driven Prioritisation Process (UDPP), whereby operators can apply their own priorities during periods of capacity shortfall, based upon a CDM approach.
- Further develop 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;
- Improve 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);
- Develop improved flight briefings for pilots and flight dispatchers, through the use of integrated digital Aeronautical (including Digital NOTAM) and MET data.

**Main activities conducted in 2016:**

During 2016, the projects in work packages 7 and 13 successfully delivered a number of SESAR Solutions relating to network operations in SESAR Step 1, Time Based Operations. This work entailed the execution of challenging integrated validation exercises with participation from a varied set of stakeholders. In addition, significant progress was made on validating concepts in preparation for further work in SESAR 2020.

- Project 07.05.04 (Flexible Airspace Management) addressed the advanced flexible use of airspace (AFUA) topic with the objective to provide more flexibility by allowing dynamic airspace management in all phases of the operations, from initial planning to the execution phase, taking into account local traffic characteristics. For Step 1, the project successfully delivered the Step 1 SESAR Solution #31 for AFUA (new ARES design principles (VPA), real-time airspace status data exchange, and interoperability between ASM, ATFCM and ATC systems) which was assessed to have achieved a V3 maturity status at the release 5 systems engineering #3 review.
- Project 07.06.01 (Collaborative NOP) addressed the evolution of the existing European Network Operations Plan (NOP).  For Step 1, the project has successfully delivered the SESAR

Solution #20 "collaborative NOP", which was assessed to have reached a V3 maturity status at the release 5 system engineering #3 review. The solution addresses the following concept features: comprehensive integration of AOP and NOP data; increased visibility of network performance; initial integration of weather information; and improved collaboration via tool support.

- Project 07.06.02 addressed business and mission trajectories management (BMT), and the user driven prioritisation process (UDPP). For BMT in Step 1, the project successfully delivered SESAR Solution #37 "extended flight plan", which was assessed to have achieved a V3 maturity status at the Release 5 systems engineering #3 review. For UDPP in Step 1, the project has successfully delivered the SESAR Solutions #56 "enhanced ATFCM slot-swapping" and #57 "UDPP departure", both assessed to have reached a V3 maturity status at the release 4 systems engineering #3 review.

- Project 13.02.02 (Aeronautical Information Management) developed and validated operational requirements, and developed and verified the corresponding technical requirements, to support the digital integrated briefing concept. The SESAR Solution for Digital Integrated Briefing was approved at the release 5 SE#3 batch 2 review held in June 2016. The project also made a significant contribution to the SWIM Global Demo.

- Project 13.02.03 has addressed the topics related to enhanced DCB (Demand and Capacity Balancing) processes from the strategic to the post-ops phase, in particular DCB in a trajectory management context, dynamic DCB, Network CDM, Airports integration into Network operations, ASM/ATFCM integration and management of critical events. For Step 1, the project successfully delivered the Step 1 SESAR Solutions #17 "Enhanced STAM" and #18 "Calculated take-off time to target times (CTOT to TTA)" which were both assessed to have achieved a V3 maturity status, with acceptable issues, at the release 5 systems engineering #3 review.

- Project 07.02 performed the operational and technical coordination across the "network" primary projects, plus the related federating activities across the programme.

In addition to the work performed for SESAR Step 1, the projects made significant progress on the early development and validation of concepts that will be progressed in the SESAR 2020 Programme.

### *WP 8 – Information Management*

**Scope:**

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.

**Objectives:**

The Objectives of WP 8 are to:

- Describe the performance and operational requirements of ATM wide information sharing;
- Strongly 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);
- Produce and document (ATM) Information Service in support to a variety of system WPs or other Industry segments;
- Directly drive the operational requirements for the technical system architecture of Information Management to be developed in the SWIM Work Package (WP 14);
- Validate deliverables from various Operational WPs in.

**Main activities conducted in 2016:**

WP08 is composed of the below listed projects;

- 08.01.01 for the main task; SWIM governance.
- 08.01.03 for the main task; information modelling.
- 08.03.10 for the main task; service development.

WP8 has been in 'steady production mode' in 2016.

The SWIM compliance framework was updated by 08.01.01 according to the experiences gained in R5 SWIM enabled exercises. This framework has been implemented for several SWIM enabled exercises and 08.01.01 project gathered the feedback during compliance checks. These checks and R2SE2 reviews were used for the improvement of the SWIM compliance framework. The new SWIM registry tool was continued to be used as the SESAR Working Method on Services (WMS) foresees the use of a SWIM Registry for publication and discovery of information related to logical services as well as service implementations. Also the outcome of the SWIM Compliance Status Report was produced to draft the outcome of the compliance checks.

The SWIM Registry was used for the following;

- As a repository of guidance materials, which will help to the service providers implement SWIM Compliant Services by identifying what needs to be done to implement SWIM compliant services;
- As an implementation repository that keeps track of all SWIM service prototypes produced in SESAR by supporting service providers to register their service implementations and allowing the consumers to discover the implemented services;
- As a repository of SWIM compliance assessments.
- Also the Registry Design Time requirements were produced by the project as well.

By using the experience of implementing and operating the SWIM Evolution Management function within the programme, an update of the SWIM Concept of Operations and IM Functions documents were produced by project 08.01.01. These documents are considered to be one of the important outputs of the SESAR programme for the first SWIM deployment. Several SEMG meetings were executed and the discussions were also reflected to the other 08.01.01 deliverables such as the SWIM foundation.

In general 08.01.03 has been steadily progressing according to plan. Last AIRM release was delivered providing a baseline vocabulary for the operational projects. The actual and consistent use of this standard vocabulary by those projects remains to be better assured. The AIRM governance has reached a mature level of operations allowing a controlled and traceable evolution of the AIRM. Also the AIRM Foundation Rulebook has been delivered as a separate deliverable.

In general 08.03.10 has been steadily progressing according to plan. Last ISRM (Information Service Reference Model) release was delivered providing the service descriptions and the model. The improved structure of the project was maintained and the project was delivered according to the agreed plan. Assessment of the delivered models was presented that the maturity level of the ISRM deliveries were increased progressively.

WP08 participated to the SCG meetings and keep their AIRM and ISRM development plans up to date according to the service roadmap (R5 validation activities). An analysis was undertaken to outline how the SCG can achieve full coverage on the development of the required services for the PCP.

All WP08 projects contributed to SESAR 2020 preparation activities such as the WMS (working method and services) and SESAR 2020 architecture definition activities.

### WP 9– Aircraft Systems

**Scope:**

The scope of the Aircraft System Work Package covers 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 Aircraft System Work Package is required to develop the necessary technological solution in support of the SESAR operational validation and ATM solution (e.g.  GBAS, Software Define Radios, D-TAXI …). The work package addresses:

- Developing and validating at aircraft level all airborne functions identified in the SESAR ATM Master Plan;
- Ensuring operational & functional consistency across stakeholder airborne segments (Commercial Aircraft, Business Aviation, General Aviation, Military Aircraft, UAS, etc.);
- Identifying technical solutions for different airborne platform types such as Mainline aircraft, Regional aircraft and Business Jets;
- Ensuring global interoperability and coordination with important external initiatives such as NextGen in the U.S.

**Objectives:**

The objectives of WP9 are to:

- Achieve a greater integration of the aircraft in heart of the performance-based European ATM system allowing an optimum exploitation of the increasing aircraft capabilities;
- Introduce progressively the 4D Trajectory management functions. Initial 4D Trajectory capabilities will require, first, the downlink airborne computed predictions on the ground to establish a sequence on a merging point, and, second, improved time constraints management capabilities both contributing to first generalise Continuous Descent Approaches from Top to Descent in mid and high density areas. A further step will allow the full exploitation of 4D Trajectory through 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;
- Enhance On-board approach functionalities and validate them to provide improved and all weather operations. This will allow initial CAT II/III GBAS L1 approach for new aircraft, providing rapid benefits under low visibility conditions. A second step will address the implementation of full multi-constellation (GPS, GALILEO) GBAS Cat II/III in the airborne equipment;
- 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;
- Address environmental impact through Advanced Continuous Descent Approach aiming at minimising fuel burning and emissions, and decreasing noise;
- 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 allow the conformance of military aircraft with new operational concepts and to enable military aircraft to fly with the same performance level than civil aircraft to better exploit airspace resource avoiding restricting part of it for military use only;

- 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, hence minimising the number of transition steps for a better cost efficiency;
- 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 (C&P) 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 (e.g. vertical or lateral C&P) and maintaining separation during that manoeuvre.

In order to support the above evolutions, enhancement and additions to the CNS Technologies are foreseen, including updates to ADS-B, Airport datalink and Flexible communication avionics and improved navigation positioning technologies while addressing the different types of airborne platforms.

**Main activities conducted in 2016:**

In 2016, 19 system projects were under execution, 1 federating project (P09.49) and 1 Management Project. All the 20 projects have been formally closed in 2016 and the Executive Decisions issued.

Of these, a maximum number of projects were fully integrated within Operational Focus Areas, namely P09.12 and P09.27 in OFA01.01.01, P09.14 in OFA01.02.01, P09.01, P09.03 and P09.05 into OFA04.01.02, P09.13 and P09.31 merged into 09.11 and within OFA04.02.01 and P09.39 P09.11 (including the scope of merged P09.30) into OFA03.03.01. It should also be noted that the previously closed projects P09.09 and P09.10 were within OFA03.02.01.

The remaining WP09 projects were grouped with WP15 projects for incorporation within three Enablers consisting of ENB01.01.03 for Communication, ENB01.01.04 for Navigation and ENB01.01.05 for Surveillance.

In terms of progress and maturity:

- 5 projects have progressed to V3 (P09.01, P09.05, P09.13, P09.14 and P09.33) and developing core step 1 airborne functions. These are used to perform a large number of operational validation activities with several operational projects and partners;
- SESAR Technical Solutions reaching TRL6 included– Airport Surface Data Link AeroMACS (09.16 / 15.02.07) and Hybrid Surveillance (P09.47), Flexible Communication Avionics (09.44 – TRL4) and SESAR Operational and Technical Solution GBAS CAT II/III GPS L1 (P9.12, P15.3.6).

The majority of projects also contributed to standardisation.

In 2016:

- Project 09.00 The work package addressed the management of development and validation at aircraft level of all airborne functions identified in the SESAR ATM Master Plan, ensured operational & functional consistency across stakeholder airborne segments, identified technical solutions for different airborne platform types such as Mainline aircraft, Regional aircraft and Business Jets, and ensured global interoperability and coordination with important external initiatives such as NextGen in the U.S.

- "Airborne Initial 4D Trajectory Management Project" (09.01) developed the airborne contribution of the Initial 4D Trajectory Management concept and operations. For Regional aircraft, the technical feasibility has been assessed with successful tests on flight simulator. For mainline, the technical feasibility, pre-industrial development and integration have been validated and considered as operationally acceptable. Moreover, mainline definition is considered being ready for transition to the industrialisation and deployment phase.

- "Airborne Full 4D Trajectory Management & 4D contract capability" Project (09.02) provided an "Analysis of Full 4 D Trajectory Management", namely a shared understanding and refinement of the FULL 4D Trajectory management concept, together with a description of how the concept should work between air and ground within the execution.

- "Interoperability of Business Trajectory and Mission Trajectory Project" (09.03) core development was related to additional "flight Management System" for State aircraft able to satisfy the i4D and separation requirements. This additional FMS is called TCA in the frame of the project

- "ASAS-ASPA" Project 09.05 addressed the complexity for the implementation of ASAS spacing (with up to five avionics systems impacted for mainline A/C) and worked on an intermediate step to pave the way towards more complex applications such as ASAS spacing. It provided early quick wins for equipped airlines and facilitated the eventual deployment of more powerful and complex ADS-B IN functions, for both mainline and business aircraft.

- "Aircraft Systems for Wake Encounter Alleviation" Project 09.11 performed some preparatory technical developments for SESAR 2020 activities on the reduction of wake turbulence risk considering wake monitoring and awareness;

- "GBAS Cat II/III" Project 09.12 included significant contributions to the definition of GBAS – GAST-D and to International standardisation, including flight trials for mainline and business aircraft.  Good progress was made on GBAS Cat 3 validation and the final SARPS in November 2016.

- "Airport Surface Taxi Clearances" Project 09.13 contributing to the delivery of SESAR 1 Solution #23 D-TAXI service for controller-pilot datalink communications (CPDLC) application in Release 5 as part of the high-performing airport operations Key Feature. The project also contributed to bringing the manual taxi routing function to a V2 maturity level, paving the way to further developments in SESAR 2020 PJ03a-01 (Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing);

- "Airport Surface Alerts (ownship and traffic)" Project 09.14 finalised its operational and technical documentation, allowing the conformance monitoring and traffic alerts safety nets for pilots to progress in maturity, paving the way to the delivery of solutions PJ03b-03 (Conformance monitoring safety net for Pilots) and PJ03b-05 (Traffic alerts for pilots for airport operations) in SESAR 2020;

-  "SWIM Air-Ground Capability" Project (09.19) aimed at connecting aircraft to the System Wide Information Management (SWIM) network to support SWIM operational aspects. The project defined generic means of information exchange between aircraft systems and the ground SWIM segment using Internet Protocol (IP) based technologies and networks. The proposed generic architecture was then refined into aircraft concept and airborne system architecture for both mainline and regional aircraft, implemented with two prototypes and verified using these prototypes

- "Mid & Full ADS-B Capability – Research" Project (09.22) confirmed that phase modulation of 1090 MHz Extended Squitter (ES) was a promising evolution of Automatic Dependent Surveillance - Broadcast (ADS-B). The selected technology was assessed by simulations,

laboratory measurements along with the impact of the proposed solution on both aircraft and ground systems.

- "Multi-constellation GNSS Airborne Navigation Systems" Project (09.027) demonstrated the state of readiness up to TRL4 of technologies for dual-frequency dual-constellation airborne receivers.
- "Enhanced & Synthetic Vision Project"(09.29) performed and reported on the last phase of the verification and validation activities, allowing the equivalent visual landing operations in low visibility conditions concept (supported by a Combined Vision System) to reach V2;
- "Aeronautical databases" Project 09.31 completed technical developments, support to validations and standardisation activities on on-board airport map data bases, enabling the airport moving map.
- "ATS Datalink Operational Improvements Project" 09.33 contributed to the definition and validation of the ATS Datalink concepts based on specifications outcomes from Datalink standardization groups (WG78/SC214). The core CPDLC services to the level of maturity for technical aspects were progressed in line with European Master Plan (ATN Baseline2 Aircraft Capacity) and Human Factors perspective with regard to the use of datalink in various flight phases.
- "Continuous Climbing Cruise Project" 09.39 considered two approaches- Continuous Climbing Cruise and En-route Optimization Technique – these were investigated with respect to safety, operational compatibility, available savings, and implementation complexity. Based on the results, electronic flight bag has been selected as viable target platform. Prototype application has been created and evaluated in simulated environment and recommendations provided regarding functional requirements and concept of operations.
- "Flexible Communications Avionics Project" (09.44) addressed the flexible radio architecture concepts, which have been verified through the development of prototypes and laboratory testing, completed by some transverse studies. One primary conclusion of the project was that the proposed concept of distributed Software Defined Radios architectures has the potential to bring many benefits at Aircraft level.
- "TCAS Evolution" Project (09.47) aimed at defining and assessing feasibility of ACAS evolutions required to support aircraft operations in the future SESAR environment. In this context it addressed the benefits associated with the implementation of extended hybrid surveillance capability into TCAS II in terms of reduced use of 1090 MHz frequency; development and validation of surveillance functions for a new generation of ACAS, referred as ACAS X; and performance study of new traffic awareness for collision avoidance systems designed for general aviation
- "AIS MET Services and Data Distribution Project" (09.48) proposed a concept for the use of AIS and MET information within the cockpit. The project led EXE-09.48-VP-811 (V2 level) to allow validating the concepts defined by the project and achieved a V2 validation of the functions that uses AIS/MET information on-board and formalised a specification of these functions (Functional Requirements and High Level Architecture). The Airspace Users (Pilots) concluded that such functions were very useful and increase situational awareness.
- "Global Interoperability - Airborne Architecture and Avionics Interoperability Roadmap Project" (09.49) was responsible for producing the aircraft level architecture, the avionics roadmap, the retrofit and the Interoperability analysis, facilitating the coordination between aircraft system projects, managing the definition and planning of aircraft enablers, and for managing the contribution of the airborne domain to the integrated roadmap / master plan. Project also contributed to developing the system-of-systems architecture and associated ATM modelling, all in coordination with the A/C system.

*WP 10 – En-Route & Approach ATC Systems*

**Scope:**

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.

**Objectives:**

The objectives of WP 10 are:

- 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;
- Define, design, specify and validate the En-route & TMA ATC Systems needed to support the SESAR ATM target concept;
- Prototype development for system and operational validation.

**Main activities conducted in 2016:**

The technical architecture activity has been consolidated with the one of the other domain under the umbrella of B04.03 to finalise the TRANSITION ADD S2020.

Several prototypes were developed and successfully used in v3 validation activities securing the full maturity of the corresponding solutions in Release 5 for Advanced air traffic services Key Feature.

Regarding IOP, P10.02.05 produced updated technical specifications, taking over open issues identified in EUROCAE.

All projects have been closed as they achieved their full scope and produced full documentation (e.g. final Technical Specification) in support of the SESAR Solutions.

## WP 11.01 – Flight Operations Centre

**Scope:**

The scope of 11.01 covers Flight Operations Centres and Wing Operations Centres. Since WP11.01 is both an operational and a system work package, the work covers concept development, validation, system development and verification.

**Objectives:**

The objective of WP11.01 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.

**Main activities conducted in 2016:**

Work Package 11.01 (Flight and wing operations centres) was performed by the Fly 4D consortium (Airbus, Airbus Defence and Space, Honeywell, Lufthansa Systems and Sabre) via a contract managed by EUROCONTROL on behalf of the SJU. During 2016, work package 11.01 projects successfully delivered a number of SESAR Solutions relating to flight and wing operations in SESAR Step 1, Time Based Operations. The work of 11.01 has been characterised by a strong engagement of airspace users.

- Work package 11.01 projects led and contributed to pre-operational, integrated validations of operational improvements for civil and military airspace users. The techniques used have included real-time simulation, shadow-mode, gaming sessions and platform-based gaming. FOC and WOC prototypes and platforms have been integrated with wider ATM platforms.
- The project has contributed to the validation of the following SESAR Solutions: Aeronautical Information Management (solution #34: Digital integrated briefing); Free Routing (solution #33: Free Routing for flights both in cruise and vertically-evolving above a specified flight level in low-to-medium density airspace); Advanced Flexible Use of Airspace (solution #31: Variable profile military reserved areas and enhanced civil-military collaboration); and Extended Flight Plan (solution #37).
- In addition, validations were also performed for other improvements such as use of Global Ensemble Weather forecast (MET information) in the flight planning process, UDPP Step 2, and the mission trajectory process (mission planning through use of iOAT and Extended Flight Plan and mission monitoring)

The life of the Fly4D consortium came to an end coincident with the closure of SESAR 1. A number of the activities from work package 11.01 activities from SESAR 1 – notably with regards to business and mission trajectories, and UDPP – will be progressed further in SESAR 2020.

## *WP 11.02 – Meteorological Information Services*

**Scope:**

The scope of the standalone Work Package, 11.02, 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.

**Objectives:**

WP11.02 addresses the requirements for meteorology within the SESAR Programme, in particular in relation to 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, a distinction should be made between the provision and exchange of MET information (the role of 11.02), and the integration and use of MET information (performed by the operational projects).

**Main activities conducted in 2016:**

Work package 11.02 (meteorological information services) was performed by the EUMETNET consortium comprising seven National Meteorological Services (UK Met office, Meteo France, DWD, FMI, met.no, KNMI and SMHI) and three industry partners (NLR, THALES and Belgocontrol) via a contract managed by EUROCONTROL on behalf of the SJU.  The work package has successfully: collated programme-wide MET requirements; designed new MET prototypes; supported operational validations; raised awareness; and provided MET expertise to operational projects.

- The MET information exchange SESAR Solution #35 was assessed to have achieved Technology Reference Level (TRL) 6 at the release 5 systems engineering review, held 29 September 2016.
- The 4D Weather Cube/MET-Gate was used to support operational validations led by other projects, as well as the TOPLINK demonstration. This solution enables tailored MET information to be made available to ATM stakeholders via a SWIM compliant MET-Gate.
- The work package's contributions to the SWIM Global Demo and the SESAR Showcase have been highly appreciated by the SJU and its stakeholders.

The life of the EUMETNET consortium came to an end coincident with the closure of SESAR 1. A number of the activities from SESAR 1 will be progressed further in SESAR 2020.

### WP 12 – Airport Systems

**Scope:**

The scope of the Airport Systems Work Package encompasses all Research & Development activities to define, design, specify and validate the airport systems needed to support the SESAR ATM target concept. It also 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.

WP 12 undertakes technical developments and verification and support to validation, providing the ground-based system support to the new concepts, procedures and practices described by WP06.

**Objectives:**

The objectives of WP 12 are 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 (i.e. wake vortex detection and prediction systems);
- 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.

All of these developments will be brought together so that they support the controller in his tasks by the prototyping of an advanced controller working position, through which a set of core HMI principles will be established.

These objectives are being achieved through a portfolio of 22 R&I projects.

**Main activities conducted in 2016:**

Throughout 2016 WP12 projects actively supported the delivery of the airport related SESAR Solutions in Release 5 by developing and verifying prototypes that were then used in V2 and V3 validations. The one of the last task in each WP12 project consisted in updating the technical specifications describing the technology associated to the SESAR Solutions delivered in Release 5. Those technologies consisted in:

- Non-conformance and conflicting clearance monitoring and alerting tools;
- Wake vortex detection/prediction tools;
- Integrated arrival and departure manager;
- A-SMGCS planning, routing and guidance tools;
- Airport operations plan;
- Airport operations monitoring and management tools;
- Advanced airport controller working positions;
- Remote tower systems.

### *WP 14– SWIM technical architecture*

**Scope:**

The SWIM technical architecture Work Package is the follow-up in the context of SESAR of the SWIM-SUIT European Commission 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.

**Objectives:**

The primary objectives of WP14 are to define and validate the technical infrastructure solution for SWIM addressing the requirements received from WP8and interfacing with all other System WPs (9-15). WP14 will in particular provide adequate support for SWIM exploitation to the other System WPs in order to ensure that system WPs can implement SWIM compliant services and service consuming applications.

In detail the objectives are to:

- Define and validate the infrastructure solution for SWIM addressing the requirement received from Information Management (WP8). The SWIM WP will have to interface with all other System WPs (9-15);
- Further develop the 'Intranet for ATM concept' by:
- Performing an assessment of the Information Management needs of the SESAR CONOPS, as scoped by WP 8, to define the SWIM technical services that will be required,
- Using the SWIM-SUIT results, to translate the results of the assessment into an architectural description, technological options and system solutions;
- Develop SWIM test platforms to support the operational and technical aspects of the SWIM validation and to provide regular SWIM demonstrations;
- Provide adequate support for SWIM exploitation to the other System WPs in order to ensure that system WPs can develop SWIM compliant services and service consuming applications

**Main activities conducted in 2016:**

WP14 projects have worked in synchronised mode on the SWIM Technical Infrastructure design, specifications and prototyping.

Projects 14.01.03 and 14.01.04 delivered the final iteration of the SWIM Technical Infrastructure architecture (TAD), the SWIM TI Profiles and the Technical Specifications (TS) according to the scope agreed with SJU. Also the 14.02.02 outcome is used as an input for these deliverables and the needed security requirements were defined in the 3.1 TS and the 3.1 TAD was also produced according to these requirements.

14.02.09 provided the SWIM prototypes and technical support for the SWIM enabled R5 exercises successfully. Also the final TS was fed by 14.02.09 project regarding the IOP requirements.

SWIM Global Demonstration (SGD) was executed to:

- Ensure that the audience understands how SWIM is supporting fundament SESAR KPAs (cost, capacity, safety, security, interoperability…),
- Increase the awareness of the global community about SWIM by practicing the ICAO SWIM CONOPS principles in reality,
- Feedback any experiences to the ICAO\IMP.

SGD activity was executed with the participation of several global partners, which are; Australia, Brazil, USA, Arab Emirates, Mongolia. Several European partners coming from the SESAR projects and SWIM Master class contributors were confirmed their participation to the event. The aim of the scenarios that were used in the SGD were to demonstrate the use of WIXM, WXXM, and AIXM on a flight (Pre-Planning, Flight Planning, Departure (Stand to Off, includes Tower), InFlight (Climb-out, Cruise), Boundary Coordination, Inflight (Cruise, Descent), Arrival (On-Final to at Stand, includes Tower), WXXM Data Sharing ( SIGMET (Severe Weather, Volcanic Ashe)), AIXM Data Sharing (OTS, SAA, NOTAM). Scenario and technical infrastructure definitions were evolved and the required milestones (such as integration, testing, etc.) were defined and started to be executed. WP 14 projects (especially 14.01.04 and 14.02.09) were provided and are providing a significant effort for the SGD to ensure the success of the event.

### *WP 15– Non Avionic CNS System*

**Scope:**

The Non Avionic CNS System Work Package addresses CNS technologies development and validation also considering their compatibility with the Military and General Aviation user needs. It identifies and defines the future mobile datalink systems to serve communication and surveillance services, the ground SWIM backbone system. It addresses the best combination of GNSS and non-GNSS Navigation technologies to support Performance Based Navigation and precision approach requirements. It proceeds 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.

**Objectives:**

The objectives of WP15 are to:

- Address subjects concerning Spectrum Management for using the spectrum in the most efficient manner and for promoting CNS spectrum allocation at ITU allowing the future CNS SESAR Concept enablers to operate properly as well as undertaking the appropriate actions to minimise the impact on aeronautical spectrum from non-aeronautical systems;
- Define the future Mobile communication system supporting the SESAR Concept, capable to provide to all the types of users the required functions and quality of service, and to support Air/Ground and Air/Air services. It will be composed of a new ground-station-based system associated to complementary systems (a satellite communication system in close cooperation with and benefiting from a related activity at the European Space Agency, a an aircraft communication system at the airport AeroMACS and a new terrestrial (continental) datalink e.g. LDACS). This set of systems will constitute the mobile part of the SWIM backbone. Interconnection of military aircraft through their specific datalink is also addressed. Enhancement of the Ground/Ground communications PENS infrastructure will also be progressed in order that it becomes the ground SWIM backbone;
- Define from a sub-system perspective, the best combination of GNSS and non-GNSS Navigation technologies to support Performance Based Navigation and precision approach requirements in a roadmap perspective as well as to enable transition from current terminal and en route operations (with a mixture of B-RNAV, P-RNAV and conventional) to a total PBN environment. In addition the refinement and validation of GNSS based precision approaches, in line with the evolution of the SESAR ATM capability levels will be performed based in a first step on GBAS Cat II/III GPS L1 and in a further step on GBAS Multi GNSS (GPS + Galileo) Cat II/III allowing rationalisation of the infrastructure and optimisation of the runway capacity under low visibility conditions;
- Consider the rationalisation of conventional terrestrial navigation aids;
- Proceed with enhancements to the ground Surveillance systems and introduction of new Surveillance systems and services (e.g. WAM, ADS-B applications beyond initial operational capabilities). Considering these enhancements and new means, the surveillance infrastructure will be rationalised by considering decommissioning legacy technologies (e.g. SSR) thus decreasing operating costs while balancing the necessary non-cooperative requirements in TMA and for military purposes;
- Decrease delays due to weather, prevent accidents, and help to improve long-term airport operation, relevant sensors matching airport category needs for detecting weather and

weather related hazards as well as the integration of their complementary characteristics will be realised.

**Main activities conducted in 2016:**

In 2016, 16 projects were under execution, and 4 management projects. Of these, all projects have now been formally closed.

- "Spectrum Management & Impact Assessment" project (15.01.06) With Spectrum being a scarce and finite natural resource and Aviation spectrum allocations are under a global threat from other sectors that are seeking additional spectrum allocations. The project developed the SESAR Strategy, Vision, Band by Band Action Plan, Implementation and Compliance processes. The SESAR Spectrum Vision and Strategy was adopted at European level and is already being integrated into the ICAO Handbook on Radio Frequency Spectrum Requirements for Civil Aviation

- "CNS System of System definition and roadmap" project (15.01.07) developed the CNS Domain Technical Architecture Document (TAD) and Roadmaps. In addition, it provided a framework for cross-domain CNS studies.

- Future Communication System project (15.02.04) focused on the Aeronautical Telecommunication Network (ATN) Internet Protocol Suite (IPS) for mobile networking and air/ground data links supporting the Future Telecommunications Infrastructure (FCI). A promising technical solution was been identified for two main functions of the FCI, i.e. mobility and multiple data link (multilink or "multihoming") management. The focus on the system elements have completed with the Future Communication Infrastructure Operational Concept along with the Quality of Service Concept. A separate VDLM2 capacity study has been completed and published. The second VDLM2 call on Measurement, Analysis and Simulation campaign was published with its recommendations accepted.

- 4D Trajectory Exchange using SatCOM IRIS Precursor (15.02.05) was designed to exploit an opportunity for early benefits in the 2017-2025 timeframe by deploying an aviation communications service based on the existing Inmarsat SwiftBroadband (SBB) service. The project developed and verified an Iris airborne prototype in an initial exercise and flight trial. It formed the SESAR Technological Solution # 109

- Future Mobile Satellite Communication (15.02.06) has progressed key deliverables, namely the SATCOM Mission Requirements Definition and Iris Interface Control Document definition after coordination and alignment with P15.02.04 FCI.;

- Airport Surface Data link (15.02.07) has completed its live trial in coordination with P09.16. The outcome was proposed as a SESAR Technical Solution #102, with supporting standardisation and global interoperability finalised;

- Navigation technologies specifications project (15.03.01) delivered the SESAR Navigation Baseline for 2020 and 2030 timelines, integrating contributions from partners for both civil and military Airspace Users. This project has provided inputs to update the Navigation elements of the ATM Master Plan

- Navigation Infrastructure Rationalisation project (15.03.02) addressed issues associated with the decommissioning of conventional terrestrial navigation aids, and developed solutions to minimize the associated risk.

- GNSS Baseline study project (15.03.04) determined the requirements on Global Navigation Satellite Systems to support European Air Traffic Management (ATM), particularly in terms of performance and robustness; to define a baseline for use of GNSS by European ATM in a first

phase until 2020 (Step 1) and a second baseline until 2030 (Step 2); it established a roadmap for the transition to the recommended baseline contained within project 15.03.01;

- GBAS Cat II/III L1 Approach (15.03.06) successful completed its validation exercises. It focused on ensuring the full benefit of GBAS on large airports, through enhanced GAST D solutions better suited to large and complex airports environments. Additional it prepared for the transition from V3 to V4; It formed part of SESAR Solution #55

- Multi GNSS CAT II/III GBAS (15.03.07) project developed the GBAS ground stations supporting multi-frequencies and multiple constellations with a special focus on integrity monitoring;

- Integrated Surveillance sensor technologies (15.04.02) project addressed the analysis of new integrated solutions for ground-based cooperative & non-cooperative ATM surveillance. It addressed the preliminary operational requirements and preliminary system requirements and a number of studies. The Improved 1090MHz ADS-B Ground station capacity and security (15.04.06) project developed the ADS-B security prototype and produced the SESAR Technological Solution #114 for Composite Surveillance ADS-B / WAM;

- "Surveillance ground station for ADS-B integration" projects (15.04.05a and b) have completed their third iterations of the SDPD prototype and their respective validation activities. The project 15.04.05.b was closed in 2015 and the 15.04.05.a closed in 2016 and formed part of the SESAr Technological Solution #110;

  - Project 15.04.09 was split into 3 elements. The final Project 15.04.09c on Weather Sensing Technologies contributed to the delivery of the SESAR Solution Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP) (Solution #21 – PCP related) with the support to some V3 validations and the delivery of the final technical specifications of the Ground Weather Monitoring System.

All projects were successfully completed and closed within 2016 with the issuing of Executive Decisions.

Due to the maturity of the CNS projects in WP15, most of the projects have contributed significantly to CNS standardisation activities within the ICAO framework or within industry standards bodies such as EUROCARE.

Airspace Users supported the projects and the added value was recognised both by project team and by airspace users.

### WP 16 – R&I Transversal Areas

**Scope:**

The scope of the R&I Transversal Areas Work Package covers the improvements needed to adapt the Transversal Area (TA) (safety, security, environment, human performance and CBA/business Case) management system practices to SESAR as well as towards an integrated management system. WP16 also provides support and coordination for the consistent and coherent application of the already existing as well as newly developed TA-related practices to SESAR operational and system Work Packages.

**Objectives:**

The Objectives of WP16 are to:

- TA R&I: Pro-actively provide SESAR projects with the best TA-related practices, guidelines, tools, methods, models and techniques (TA Reference Material) in function of needs and areas of improvements identified;
- TA Support & Coordination Function (Safety, Security, Environment, HP): Ensure coordination & consistent approach of TA aspects and application of TA practices throughout SESAR Development Phase, including a contribution to validation acceptance for TA aspects, as well as coaching to support production of evidence on the acceptability of Operational Focus Areas (OFA) from a TA perspective,
- Collect, assess and report upon SESAR Cases per TA assessment area with the aim to identify and mitigate TA-related issues in projects and to aggregate in performance views at programme and masterplan level.

**Main activities conducted in 2016:**

In 2016, WP 16 via the involvement of projects (16.06.01 to 16.06.06 covering the domains of Safety, Security, Environment, Human Performance, CBA and Business Cases) continued to provide support and harmonise a common approach to enable aggregated performance assessments and provide consolidated Business Cases. It did this by working closely together with the WP C Master Plan projects, ensuring the provision of aggregated performance views and consolidated CBAs. These were used to introduce a performance driven approach to the Master Planning process.

In addition WP16 projects further enhanced methodologies for the Key Performance Areas (KPAs) Safety, Security, Environment, Human Performance and CBA/Business Case assessment. These methodologies consist of documented methods, processes, templates and software tools. In addition, WP16 has supported deployment of the methodologies in the operational solution projects by providing training and hands-on assistance, with the result that there is now a significant knowledge-base in the operational solution projects on how to apply the methodologies.

WP16 has also assisted the SJU in external coordination with a number of bodies notably including EASA for Safety and Environment, ICAO CAEP for Environment, and Staff Associations for Human Performance impact of operational solutions.

All WP 16 projects were formally closed in Q3/4 2016.

### *WP B – Target Concept and Architecture Maintenance*

**Scope:**

The scope of the Target Concept and Architecture Maintenance Work Package covers the maintenance and refinement of the high-level ATM Performance Target and Architecture including the Concept of Operations (CONOPS). It defines and ensures the consistency of the ATM architecture for all SESAR WPs. WPB will also conduct a performance analysis of the ATM Target Concept throughout SESAR development phase.

**Objectives:**

WP B will contribute to the ATM Master Plan Achievement by updating and refining the ATM Target Concept as input to other WPs, analysing the performance of the ATM system and ensuring that the Target Concept meets the performance requirements.

The role of WPB was revisited and PC13 agreed on the following updated objectives:

1. To develop proposals for ATM-related content in the following main areas:

   o performance framework;
   o high level business model;
   o high level concept of operations;
   o high level architecture of ATM technical systems; and
   o architecture principles.

2. To identify inconsistencies of the content with the top down approach of the programme and to propose mitigating actions by:

   o preparing, contributing to and performing SE Reviews for the Releases;
   o using, to the relevant level and detail, Enterprise Architecture as a tool; and
   o applying SESAR strategies in the evolution of European ATM.

3. To focus on content produced by the federating projects.
4. To support the SJU in managing the release approach as laid down in the "SEMP Application Guidelines".

WP B is in charge of developing, where requested by the SJU, further guidance to support the application of the SESAR strategies. The guidance material produced will be used to support developments by operational, system and SWIM projects.

**Main activities conducted in 2016:**

in 2016, WP B via the involvement of 7 projects continued to co-ordinate and maintain the high level ATM Target Concept and the corresponding European ATM Enterprise Architecture both addressing and detailing the ATM Concept of Operations, the ATM Operational Services (including CWP-related services and the concept of Common Services) and the Technical Systems' architectures, and consolidating the performance benefits validated by the projects to obtain the overall SESAR performance assessment vis-à-vis the Performance Framework elaborated beforehand. Broken down per project the work delivered was:

- B.04.01 covered the performance and business aspects, including the determination of validation targets. In addition, B.04.01 investigated the applicability and feasibility of an

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European ATM Architecture (EATMA), – after successful validation – developed the EATMA framework and "deployed" the EATMA within the SESAR Programme;

- B.04.02 elaborated the operational aspects, summarized in the SESAR Concept of Operations (CONOPS) documents;
- B.04.03 focussed on the technical systems' aspects, described in the Architecture of the Technical Systems Description Documents (ADDs). In addition, B.04.03 developed the service architecting process;
- B.04.04 defined services related to the Controller Working Position (CWP) and the underlying data exchange mechanisms;
- B.04.05 elaborated methods for the discovery and definition of Common Services that will make it possible to harmonise the provision of air navigation services in the context of SESAR. In this context the Common Services Remote Tower and Extended AMAN were investigated.
- B.05 assessed the performance of the Target Concept with respect to the validation targets defined by B.04.01 by means of using the results of the validation work undertaken in the SESAR Programme's R&D activities.

Furthermore, during the entire year 2016, the SJU in collaboration with transversal projects in WP B, WP C, WP 3, WP 16 and federating projects like X.02 and X.1.7s have prepared tools, guidance and methods in form of transition deliverables so to prepare the ramp-up of the SESAR 2020 programme. This work has contributed and resulted in the set-up of a framework to provide guidance to project managers (Horizon 2020 Action Coordinators) of SESAR 2020 industrial research (IR) and very large-scale demonstration (VLD) projects with the aim to execute the European ATM Master Plan.

All WP B projects were formally closed in Q3/4 2016.

### WP C – Master Plan Maintenance

**Scope:**

WP C will contribute to the ATM Master Plan Achievement by ensuring a seamless link between R&D and Deployment (both plans fit within the scope of the Master Plan) by supporting processes that will ensure that performance objectives are met.

The scope of the Master Plan Maintenance Work Package is to administrate the up-to-date maintenance of the ATM Master Plan to monitor the progress of development and of implementation. It also maintains the standard and regulatory roadmaps as well as the SESAR business cases.

**Objectives:**

The objectives of WP C are 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,
- Administrate the overall process to keep the Master Plan up-to-date, and propose amendments to the SJU Administrative Board,
- Include a renewed process that delivers the Single European Sky Deployment plan and provides input for development of local/regional performance based implementation plans and targets;
- Monitor and report on the achievement of these local/regional plans and derive the impact on system wide performance too,
- Maintain the overall standards and regulatory roadmap from the capture of needs to the definition, development and validation of standards and rules, including the roadmap for regulatory enablers.

**Main activities conducted in 2016:**

A substantial effort was devoted to a major overhaul of the Master Plan Level 3 implementation Plan 2016 and Implementation report 2015, so as to upgrade these documents to a strategic level. Both documents now include an Executive summary and a Strategic view, aiming at bringing to decision-makers useful information on the objectives for concrete SESAR deployment and a description of its state of implementation.

In doing this, care was taken to ensure convergence between these documents and SDM's Deployment Programme for all PCP-related elements.

Level 2 of the Master Plan (Dataset 16) was placed for the first time on the public extranet portal to demonstrate the coherence and control of all three levels of the Master Plan.

Work Package C also delivered several key documents that will be used by Solution projects under SESAR 2020, and notably:

a document containing the proposed Operating Environments and Sub-operating environments that will be used to establish deployments scenarios and business cases;

Guidance material for Solution Projects to establish their Standardisation and Regulatory needs, which will come as a complement to the SESAR Handbook.

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These documents are now part of the Baseline to be used by SESAR 2020 Solution Projects.

Work Package C managed a timely and smooth closure of all its tasks, and in parallel a successful ramp-up and start of activities of Project 20, which will ensure Master Planning activities support under SESAR 2020.

### *WP E – Long Term and Innovative Research Programme*

**Scope:**

Long term / innovative research addresses 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 encourages the ATM research that explores novel, unconventional areas involving new technologies, concepts or ideas. It stimulates 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).

**Objectives:**

The objectives of WPE are to establish Research Networks, PhDs and a portfolio of Research Projects to explore several topics (concept element and/or technology) extending the SESAR vision without any predefined time frame.

- Towards higher levels of Automation in ATM;
- Mastering complex systems safely;
- System Architecture & System Design;
- Information Management, Uncertainty & Optimisation
- Enabling Change in ATM

The research themes have been used to establish the work in WPE to date, consisting of three Research Networks, more than 20 PhDs and 40 Research Projects (details can be found on the SJU website). WP-E is the package dedicated for ATM long-term and innovative research activities, encompassing:

- Research Networks – HALA ATACCS/CW Data Science workshop;
- PhDs;
- WP_E Call 2 Research projects;
- SESAR Innovation Days;
- Young Scientist Award Prize.

The Research Networks, through involvement of a wide range of universities, research centres and industries, offer a structured way to build competence and capability that will not only continue to serve the needs of the ATM sector in the long term but will also be valuable for other sectors. They also select and manage the PhD activities in their area of competence.

Research Projects are selected by the SJU and assigned to a Research Network that provides ongoing scientific support.

Founding Members

### *Large-Scale Demonstrations delivery in 2016*

In 2016, the 14 remaining Large Scale Demonstration (LSD) activities delivered their final reports and results and were closed: 12 Large-Scale Demonstration and 2 specific Remotely Piloted Aircraft Systems (RPAS) demonstration activities:

**Optimised Descent Profiles (OPD)**

*Domain/Topic*

TMA/CDO

*Main Project Objectives*

Design, validation, implementation and operations of cross border arrival management procedures, in support of Continuous Descend Operations (CDO).

*Results*

The project has demonstrated large scale cross-border optimised profiles. It can be clearly said that the development and implementation of cross-border descents and CDO routings is possible even in high density airspaces. However, with today's commonly used methods and rigid sector boundaries, it requires good preparation work and a proper understanding of each other's working methods to avoid early descents.

In densely used airspaces optimum profiles might not be achievable most of the time. The most common reasons that lead to constraints for arriving aircraft are:

- Crossing traffic flows of significant proportions.
- ATC control sectors that need to be avoided in order to prevent situations of excessive workload.
- Limitations in Approach airspace (e.g. hand-over conditions, terrain)
- Military airspaces, such as exercise areas (e.g. TRAs) etc.

The project demonstrated overall performance gains in vertical profile optimisation. For a wider-spread implementation of CDOs or optimised profiles, new concepts including airspace re-design and support tools are needed in order to minimise workload and limit the impact on working environments. However, in high density traffic areas, even airspace re-design and improvement on support tools will not enable CDO without impacting capacity.

**Budapest 2.0**

*Domain/Topic*

TMA/RNP

*Main Project Objectives*

Combination of three SESAR solutions:

1. Use of 'merge-strip' to assist with CDA/CCD.
2. Implementation of RNP procedures at Budapest airport

3.  Implementation of Remote Tower operations at Budapest.

*Results*

The main conclusions of the project are the following:

- CDO operations can be effectively supported with the appropriate procedural and software tools. Positive impacts were observed both on safety, environment and even cost-efficiency related aspects of CDO.
- For a significant improvement in CDO performance, full airspace and procedure reconfiguration, proper training for pilots and ATCOS are inevitable, and suitable software is a great advantage.
- The RNP APCH procedures to the four runway ends of Budapest Airport have been successfully designed, validated and implemented.
- Regarding Remote Tower, the current level of technology is generally capable of providing the background for safe ATS service provision. However, to secure the continuous and safe operation from a remote tower facility, the visualization needs to be carefully fine tuned to the local environment and to the well-defined concept of operations.
- The importance of human factor aspects of the Remote Tower solution has been confirmed. The change of visualisation is big enough on its own to put the focus on the human factors in the system, but in an operational environment where several ATCOs work together as a team and rely on the video images, it gains special importance.
- The implementation of the Remote Tower concept in medium size airports has other motivations than that of small airports which shifts emphasis from pure cost-efficiency motives to capacity considerations.

**RISE**

*Domain/Topic*

TMA/RNP

*Main Project Objectives*

Define, test and demonstrate RNP procedures at 10 airports in Greece, France, Cyprus and the Azores.

*Results*

More than 500 demonstration flights were achieved to Madeira, Nice, Ajaccio, Corfu, Iraklion, Mykonos, Santorini, Paphos and Larnaca, using the developed RNP1 to ILS, RNAV Visual, RNP APCH and RNP AR procedures.

The results of the project highlight the benefits linked to the use of those procedures in terms of accessibility, safety enhancement, trajectory repeatability, avoidance of sensitive zones for all places where procedures have been designed. It also demonstrates track miles and fuel consumption reduction for some of the airports.

Those results clearly illustrate stakeholder interest and support in current PBN implementation plan in Europe

## PROuD

*Domain/Topic*

TMA/RNP

*Main Project Objectives*

Enhance rotorcraft operations, particularly for HEMS flights, by the implementation of PBN approaches for arrivals, departures and connection to low-level IFR routes.

*Results*

PROuD, through campaigns for a total of approximately 80 test flights performed in Switzerland and Norway, demonstrated in a live trial environment, how the adoption of PBN flight procedures improves the safety and reliability of operations and landing site accessibility in challenging environments such as in adverse weather conditions or mountainous areas. It implies significant improvements for the general population in the experience of medical assistance by air.

Several types of procedures (PinS RNP APCH to LPV minima, helicopter RNP AR APCH procedures, PinS departure procedures, Low Level IFR Route) and phases of flight have been assessed within the PROuD project, aiming at demonstrating the real operational and safety benefits for HEMS operators.

## Free Solutions

*Domain/Topic*

En-route and  NOP/ Free Route

*Main Project Objectives*

Definition of operational solutions for

- City pair optimization
- Cross border direct routing
- Free routing during weekends

*Results*

In the framework of Free Solutions project a thousand of flight trials were executed, demonstrating the feasibility of Free Route operations with the current systems and operational procedures. This was achieved through the use of both direct routing and free routing operations, leading to the delivery of a set of measured benefits in terms of reduced fuel burnt and related CO2 and NOx emissions, reduced flight time and routes length. Those benefits were compared against current daily operations (i.e. reference scenario) and were measured for the trials periods only. The overall results of the project showing that the project demonstrated the expected benefits, in terms of fuel efficiency-environment sustainability and with no negative impact on the safety of operations and both local and network operational capacity.

## Pegase (Provoiding Effective Ground & Air data Sharing via EPP)

*Domain/Topic*

En-route/ SWIM, ADS-C EPP

*Main Project Objectives*

Assessment of the performance characteristics of EPP data provided live by real flights through high density continental airspace and assess communication.

*Results*

The demonstration project conducted a flight campaign using Airbus A320 aircraft and comprised 59 flights over a 15 month period, downlinking real ADS-C EPP data. This is the first significant assessment of the application of real downlinked EPP data.

Initial results indicate that downlinked EPP data in its current form may have the potential to improve the performance of ground-based trajectory predictors, which may in turn increase airspace capacity and reduce controller workload. FMS trajectory prediction output also shows potential to be used to support longer-range processes such as AMAN and DCB. The value of EPP data may be improved if combined with greater alignment between air and ground planning trajectories.

**iStream**

*Domain/Topic*

Airport and NOP/TTA

*Main Project Objectives*

The objective of the iStream (integrated SESAR TRials for Enhanced Arrival Management) project will evaluate through in-flight trials the benefits of several concepts on the flight efficiency, validate the capability of on-board and ground systems and will evaluate how crews, ATCOs, local FMPs, NMOC and airport operators can handle the procedure and possible consequences as well as the impact on traffic complexity and staff workload. The evaluation and validation will be performed on commercial flights landing in European major hubs during time periods when traffic load is exceeding capacity and the ATFCM delays are significant (or STAM measures are to be implemented to alleviate delay). It will involve major European actors, airlines and ANSPs.

*Results*

The iStream project aimed at demonstrating the feasibility and operational benefits of Target Time on complete flows.

The exercises performed in iStream have shown the benefits of Target Time on complete arrival flows to Zurich and Paris-CDG airports during peak and off-peak hours in the current environment.

Furthermore, iStream demonstrated the added value of local and collaborative tools and processes to solve hotspots.

**E-CRA**

*Domain/Topic*

Airports/A-CDM

*Main Project Objectives*

The project proposes to introduce SESAR concepts and technologies within regional medium size airports by demonstrating that stakeholders at regional airports and the network can benefit from the A-CDM and APOC implementation on limited investment by the deployment of a low cost system built upon a pre-existing enhanced simulation platform.

The proposal foresees gaming and shadow mode trials where flights will be observed by operational experts.

*Results*

E-CRA demonstrated:

- An exercise illustrating the collaborative management of meteorological adverse or disruptive runway conditions under nominal or exceptional traffic;
- A live trial illustrating the management of a runway disruption (runway closure) on the airport;
- that Bordeaux Airport stakeholders, and more generally a large range of Regional Airports stakeholders, can achieve the necessary optimized services through collaborative decision making that bring benefits to operations and efficiency.

E-CRA has demonstrated the benefits of up to date data, common situational awareness and collaborative decision making at regional airports. Furthermore, a predictive "what-if" tool demonstrated the utility of being able to quickly model future demand in supporting the collaborative decision making process.

**Augmented Approaches to Land**

*Domain/Topic*

Airport/ GBAS/SBAS Advanced procedures, SVGS advanced procedures, EFVS Advanced procedures;

*Main Project Objectives*

Design and demonstration of augmented approach procedures for small and medium airports, using four different technologies: GBAS/SBAS Advanced procedures, SVGS advanced procedures, EFVS Advanced procedures; and enhanced flight planning and advanced information (rather small part of project compared to the rest).

Intention of the consortium is to pave the way to improve the regulation and to help the market take-up of for the needed technologies.

The trial will use six different airports across Europe, and should involve more than 200 flights (about half business jets, the other different types of aircraft of scheduled airlines).

*Results*

This Large Scale Demonstration project has shown the benefits for the aviation community with respect to lowering decision minima, reducing environmental impact, saving fuel cost, and increasing the traffic throughput at airports. The demonstrated technologies were GBAS – Ground Based Augmentation System, RF Legs - Radius to Fix legs, SBAS – Satellite Based Augmentation System, SVGS – Synthetic Vision Guidance System, and EFVS – Enhanced Flight Vision System technologies. Project targeted also airspace users without their own Flight Operation Centre providing EFP&AI (Enhanced Flight Planning & Advanced Information). Over 360 successful demonstration flights were performed comprising revenue flights as well as flight test aircraft. Flights took place at small/medium airports (Bergerac, Perigueux, Groningen, Ostrava, Brno, Karlovy Vary and Bremen) and large airports (Frankfurt, Zurich). Using data collected during demonstration campaign, the accuracy as well as feasibility of advanced procedures (from pilots and ATC perspective) were evaluated. In addition to that, noise measurement evaluation for the RNP to xLS procedures performed in Frankfurt, as well as EFVS testing in the Fog Chamber, Full Flight Simulator and real flights. All trials were supported by several benefit simulations and benefit studies focusing on environmental impact, cost benefits or airport accessibility and capacity aspects. Thanks to the synergy of various stakeholders present in the project consortium this deliverable provides a holistic view on the wide range of technologies and their capabilities with the goal to help speed up their deployment. It can be said, above all, that the demonstration flights in this AAL project brought a positive impact to acceptance of this new technology by the market. This will stimulate an increased deployment in the market, through which it will enjoy much faster the actual realization of the benefits, and thus support the ultimate goal of SESAR ATM modernization.

**Racoon**

*Domain/Topic*

Airport/Remote Tower

*Main Project Objectives*

The demonstration would consist of the Remote Tower Center providing remote airport services combined with RNAV procedures for these airports, for the night-time operations. No non-nominal conditions will be included in the demonstration. Approach procedures with Vertical Guidance relying on Barometric RNAV and/or LPV relaying on SBAS will be designed, implemented and published at the demonstration airport.

The consortium is proposing to install the remote airport at Milano Malpensa airport to act as a Remote Tower Center for the cluster of airports.

*Results*

The Remote Airport Concept Of OperatioN (RACOON) project demonstrated, in a live environment and along with real operations, the technical and operational practicability of delivering Aerodrome ATS for a medium traffic density airport from a remote location and, under given operation conditions (e.g. weather conditions, number of movements) and technological assumptions, how ATS services can be shared for multiple airports. The project, building on the SESAR experience from the recently available V3 maturity solution "Single Remote Tower operations for low traffic volumes", deployed the technologies and developed procedures and authorisations required to operate the traffic by a remote location, with no degradation in the current service and safety levels.

Additionally, despite the main focus of the demonstration was on Remote TWR solution, the Project covered also the use of GNSS-based procedures (RNP-APCH) and the development of a GNSS monitoring solution (GNOME). GNSS procedures were designed and applied at the demonstration airport to provide Airspace Users with precision approach procedures not relying on ILS, applying minima lower than current non-precision aids.

Focus of the demonstration was the Live Trial execution, while Real Time Simulations and Shadow Mode sessions were performed as preparatory activities to the fight trials.

Through the involvement of all interested stakeholders, including regulators, RACOON project aimed at facilitating and speeding-up the process of acceptability of the SESAR Remote Tower and Approach Procedures and Vertical Guidance concepts for their further deployment and exploitation in Europe, taking into account the expected benefits that these two concepts can generate, especially in the field of cost efficiency, service availability and continuity, while maintaining the required Safety and Security level of performances.

The main theatre of operations targeted by RACOON was represented by Milan Linate Airport (LIML) – medium sized single runway airport – in the wider context of the North-West Regional Traffic Cluster which has been defined by the National Plan for the Italian Airports. In particular, Milan Malpensa (LIMC) was considered as the Strategic airport for hosting the Remote Tower Centre (RTC) and Milan Linate was the airport operated remotely through the Remote Tower Module (RTM); in addition, a third generic airport (a portion of LIMC, referred to as LIXX) was used for remote operation, through a second RTM, in order to preliminary demonstrate the Remote Tower Service for Multiple Airports (one local and one remote).

A total of 179 commercial flights joined to the RACOON demonstration activities: 118 on Remote Tower Services (RTS) solution and 61 on Non-conventional Approach procedures (RNP-APCH).

For all KPAs addressed and solutions demonstrated, results were obtained from quantitative and qualitative analysis and considered both Ground (Controllers) and Airborne (Pilots) perspectives.

As for Remote TWR Services, technical feasibility and operational applicability of this solution was successfully demonstrated, technical/operational capabilities and usability of the supporting technology were positively assessed as well. The remote provision of Air Traffic Services (ATS) for single airport resulted viable and acceptable, while the multiple airport solution requires further study. It is noted, in fact, that the multiple airport scenario - Malpensa (local) and LIXX (remote) - was characterized by a lower level of realism due to the peculiarity of the experimental settings. Importance of adequate training was also remarked to allow controllers becoming familiar with the new equipment, with special emphasis on the video solutions.

From a Pilots perspective, Remote Tower Services resulted transparent compared to standard operations: no additional workload, no change in working methods, no additional training required, no changes in terms of Role and Responsibilities (between Pilots and ATC), no trajectory deviation.

RACOON was the first Italian case-study on Remote TWR concept and the experience gained paves the way to additional developments on its applicability and deployment in the Italian context as well as contributes to mature the remote towers solution towards medium/high traffic density aerodromes.

RACOON experience confirmed that Remote Tower Services are a promising solution delivered for deployment by SESAR, the European flagship project for air traffic management modernization

(ATM). They offer new business opportunities for airports in Italy and, more in general in Europe, where it is too expensive to maintain conventional tower facilities and services, or where such services are currently unavailable.

As for RNP-APCH procedures, no negative impact on controllers' and pilots' operational tasks - in terms of working methods, workload and situational awareness - was experienced. The procedures resulted highly reliable and repeatable, allow for an optimisation of TMA airspace and bring benefit on fuel efficiency and on Access & Equity KPA by encouraging not-ILS equipped airspace users. Additionally, the GNSS monitoring solution developed in RACOON provided a layout suitable for future operational use and is expected to support further deployment of these procedures in Italy and in the Blue Med FAB area, especially at airport where not ILS procedures are currently available.

**Remote Towers**

*Domain/Topic*

Airport/Remote Tower

*Main Project Objectives*

The project seeks to enable the remote provision of tower air traffic services at Shannon and Cork from a remote facility in Dublin.

Principally aimed at periods of low traffic intensity, it will investigate the art of the possible, including operations at multiple airports from a single facility.

*Results*

The general conclusions and recommendations of Project are as follows:

- Safety: The live trial exercises demonstrated that the ATS provided by the RTC for a single airport and two medium airports by a single Controller with 'in sequence' and 'simultaneous' aircraft operation was at least as safe as the ATS provided by the Local Towers at Cork and Shannon aerodromes. There was no ATS safety occurrence report nor did any operational safety issue arise during the conduct of the fifty live trial exercises.
- Capacity: The live trial exercises demonstrated that Aerodrome Control Service could be provided by the RTC for Cork and Shannon in single airport or multiple airport modes by one Controller 'in sequence' during periods of low aircraft movements. Aerodrome Control service for 'Simultaneous' aircraft operation was possible during these periods but spacing would be required when the arrival/departure times at the two airports coincided.
- Cost efficiency: The Demonstration provided confirmation that a multiple remote tower solution provided the potential for more cost effective deployment of human resources during periods of low aircraft movements, particularly when combined with other initiatives such as the centralisation of Approach Control Service and for contingency purposes.
- Human performance: MRTO (Multiple Remote Tower Operation) is the future for safety and capacity of air traffic control at small/medium airports. However, there is a trend of increasing mental demand, physical demand, temporal demand, effort, and frustration on multiple remote tower operations compared to local tower operations across all the trials based on NASA-TLX. There is a requirement to address the issue of Controllers' perceived

Approved

workload for performing multiple remote tower operations either by training, staffing, designing new standard operating procedures or interface design, as workload can negatively affect a Controller's performance and increase the potential for error.

**RTO**

*Domain/Topic*

Airport/Remote Tower

*Main Project Objectives*

Project will demonstrate remote tower services (AFIS and ATC) at single tower locations in the Netherlands, Sweden and Germany using live and shadow mode operations. More than 50 flights are proposed, and more than 100 is possible.

A demonstration of control at multiple airports is proposed in a simulated environment.

Considerable engagement with ANSP and regulator has occurred and will continue to proceed during the demonstration.

*Results*

All different remote tower solutions from very small to medium size aerodromes were demonstrated with no significant shortcomings. ATS can safely be provided from a remote location and capacity can be maintained. Initial CBAs have shown positive results but for each aerodrome a specific CBA considering the local factors is required being the baseline for a deployment decision.

During all demonstrations operators (ATCO and/or AFISO) where able to work on the basis of existing rules and regulations for providing Air Traffic Service.

Different solutions of both camera tower and Controller Working Position were demonstrated showing that there are several ways to make Remote Tower Service a reality. Cameras covered 360 degree at all demonstrations, the image was either completely displayed continuously or just a selected field of view (e.g. 240 degrees) were shown to the ATCO continuously with the feature to pan the viewing direction.

**Toplink - L1**

*Domain/Topic*

En-route/SWIM

*Main Project Objectives*

The project aims at demonstrating the benefits of the deployments of SWIM including MET services, Aeronautical services, corporate network services and Flight Information services.

Project will demonstrate, based on an end to end supporting infrastructure , how Air Traffic Flow Management Controllers, Airport operators and commercial Airlines staff could improve their operational performance by the use of this new Information services.

*Results*

The project has clearly demonstrated the high added value of combining MET, AIM, Flight information to support strategic & pre-tactical decisions, and producing :

- a positive impact on all targeted performance KPAs (fuel & cost efficiency, predictability, punctuality, airspace capacity)
- a better situational awareness resulting in reduced stress in abnormal / fast evolving situations
- an Increased safety through a better anticipation of unexpected events

Furthermore, the project has demonstrated the benefits of a tight interaction between ground and cockpit operators in pre-tactical, anticipated actions to support decisions. One important lesson learned is the need to filter information, in order to focus pilot's resources on the relevant info only.

Finally, the project has demonstrated that tangible results could be achieved (under some pre-conditions) in such Use Cases as:

- Better tailoring of MET-induced regulations (ground delays) by ACC and Airports with an immediate impact on all Airspace Users
- Better anticipation of MET-related issues for Airspace Users to more efficiently manage flight plans revisions, and avoid costly « last minutes decisions » (e.g. late vectoring, diversion, holding)

**Toplink – L2**

*Domain/Topic*

En-route/SWIM - MET and AIM

*Main Project Objectives*

The project pretends to demonstrate cost innovative ground and cockpit solutions for the provision of network B2B information services, Met services, ATC and AIM information services to general aviation users.

It will implement low cost FOC solution for general aviation users as well as a low cost cockpit solution based on EFBs and connection (wifi, 3G/4G, iridium Satcom, ACARS…).

130 flight trials will be performed by ENAC providing that the deployment of on board low cost solution equipment's will be approved by the safety authority ( NSA).

*Results*

In flight planning operations, the use of a tablet is considered as efficient for collecting relevant information, filtering and saving it and preparing a flight folder, easy to use on board.

In cockpit operations, a better knowledge of weather conditions and a better readability of the NOTAMs have been proven as major factors to improve the GA flight safety.

The main identified benefit is the improvement of flight predictability (rather than cost or fuel efficiency).

In terms of post-flight operations, the capability to replay a flown situation is firstly dedicated to the flight safety. But some other benefits may occur rapidly. They are for example: the improvement of training method when the operator has pedagogical activities, improvement of OPS Manual for all operators. The exercise has pointed out all the possibilities of such a function, at both operator level and operator community (provided they agree to share information).

**EVA**

*Domain/Topic*

En-route and NOP/ low cost surveillance equipment

*Main Project Objectives*

This project aims at evaluating in live conditions the use and benefits of low cost surveillance equipment, on board by GA pilots and on ground by ATC. It also covers regulatory and certification aspects.

The consortium proposes to test different low-powered ADS-B equipment. The main objectives are to assess the users' situational awareness, to assess feasibility and benefits of using such equipment, interoperability between different types of same-purpose equipment, to address the regulatory issues and develop guidance material for European aviation standards.

*Results*

This project has collected quantitative and qualitative evidence from 53 demonstration flights using traffic information enabled by one or more Electronic Conspicuity (EC) technologies to improve the efficacy of the 'See and Avoid' concept, which was evolved into 'See, BE SEEN and Avoid'.

EVA has demonstrated the potential of un-certified portable ASD-B devices in the GA VFR EVAcq application to augment the efficacy of pilot's visual scan, which often resulted in more probable and earlier visual acquisition of other aircraft.  The demonstration flights also highlighted drawbacks of using EVAcq devices, which sometimes compromised the effectiveness of GA pilots' visual scans.

## Annex I.1.2        The Release #5

*Release #5 validation sites*

Release 5 addresses 42 potential SESAR Solutions through 43 exercises all over Europe:



**Figure 12: Map of Release 5 validation sites**

Founding Members

EUROPEAN UNION    EUROCONTROL

### Release #5 outcome summary

The tables below identify, for each of the Key Features, the SESAR Solutions which have been delivered in 2016 through the Release #5, their status, and the Validation Exercises that have enabled to assess them.

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| #17 | Advanced short-term ATFCM measures (STAMs) | Y | ATM | EXE-13.02.03-VP-700 | Advanced Short Term ATFCM including Network Supervision and interface with Local Tools | V3 - TRL6 | Potential SESAR Solution |
| #18 | Calculated take-off time (CTOT) and target time of arrival (TTA) | Y | ATM | EXE-13.02.03-VP-749 | TTA / TTO Management | V3 - TRL6 | Potential SESAR Solution |
| #19 | Automated support for traffic complexity detection and resolution | Y | ATM | EXE-04.07.01-VP-005 | Complexity Management in En-Route by ATC team applying trajectory management measures | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-05.03-VP-804 | Tactical complexity measures in the E-AMAN horizon | | |
| #20 | Initial collaborative network operations plan (NOP) | Y | ATM | EXE-07.05.02-VP-710 | Real time airspace status data exchange | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-07.06.02-VP-713 | EFPL usage in flight planning, DCB and ATC operations. | | |
| | | | | EXE-13.02.03-VP-700 | Advanced Short Term ATFCM including Network Supervision and interface with Local Tools | | |
| | | | | EXE-13.02.03-VP-749 | TTA / TTO Management | | |
| #31 | Variable profile military reserved | Y | ATM | EXE-07.05.02-VP- | Real time airspace status data | V3 - TRL6 | Potential SESAR |

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | areas and enhanced civil-military collaboration | | | 710 | exchange | | Solution |
| | | | | EXE-11.01.05-VP-789 | Validate State Airspace User Processes in Step 1 Lot #2 | | |

**Table 18: SESAR Solution conclusions summary at the completion of Release #5 (2016) for the Key Feature "Optimised ATM network services"**

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| #01 | Runway status lights | | ATM | EXE-06.07.01-VP-232 | Runway status lights validation | V3 - TRL6 | Potential SESAR Solution |
| #02 | Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances | Y | ATM | EXE-06.03.01-VP-699 | Level 4 A-SMGCS control, routing and guidance through D-TAXI, integrated in a CWP | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-719 | Airport Surface Management Integration | | |
| | | | | EXE-06.03.01-VP-758 | Integration of airport safety nets, advanced surface routing in a CWP | | |
| | | | | EXE-06.03.01-VP-761 | Integration of advanced CWP and Surface Management functions - OFA1.2.1, 4.2.1, 6.1.1 | | |
| | | | | EXE-06.09.02-VP-679 | Integration of A-CWP and A-SMGCS Level III/IV | | |
| #04 | Enhanced traffic situational awareness and airport safety nets for vehicle drivers | | ATM | EXE-06.03.01-VP-724 | Validation of vehicle's driver SESAR Operational Concept | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.07.01- | Live Trials on Alerts for Vehicle | | |

Founding Members

EUROPEAN UNION     EUROCONTROL

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | | | | VP-769 | drivers in Dublin | | |
| #12 | Single remote tower operations for medium traffic volumes | | ATM | EXE-06.08.04-VP-640 | Single Remote Tower - Phase2 Shadow Mode V3 | V3 - TRL6 | Potential SESAR Solution |
| #13 | Remotely-provided air traffic services for contingency situations at aerodromes | | ATM | EXE-06.09.03-VP-062 | EXE-06.09.03-VP-062; Contingency Remote TWR Live Trial 2 | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.08.04-VP-752 | Contingency Remote Tower | | |
| #14 | Departure management integrating surface management constraints | | ATM | EXE-06.03.01-VP-719 | Airport Surface Management Integration | Closed | Results should support R&D in SESAR 2020 PJ02.08. Related OI step to be removed from ATM Master Plan |
| | | | | EXE-06.08.04-VP-343 | Validation of Advanced AMAN-DMAN-Routing Step2 V3 | | |
| #15 | Integrated and throughput-optimised sequence of arrivals and departures | | ATM | EXE-06.08.04-VP-343 | Validation of Advanced AMAN-DMAN-Routing Step2 V3 | Closed | No improvement compared to uncoupled AMAN/DMAN and Solution #54 |
| #21 | Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP) | Y | ATM | EXE-06.03.01-VP-010 | Integrated Validation of the DCB Monitoring & Management Process | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-669 | Close out Airport Integration through SWIM | | |
| | | | | EXE-13.02.03-VP-749 | TTA / TTO Management | | |

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | | | | EXE-06.03.01-VP-549 | Integration of landside process information into the AOP | | |
| #22 | Automated assistance to controllers for surface movement planning and routing | Y | ATM | EXE-06.03.01-VP-699 | Level 4 A-SMGCS control, routing and guidance through D-TAXI, integrated in a CWP | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-758 | Integration of airport safety nets, advanced surface routing in a CWP | | |
| | | | | EXE-06.03.01-VP-761 | Integration of advanced CWP and Surface Management functions - OFA1.2.1, 4.2.1, 6.1.1 | | |
| | | | | EXE-06.09.02-VP-679 | Integration of A-CWP and A-SMGCS Level III/IV | | |
| #23 | D-TAXI service for controller-pilot datalink communications (CPDLC) application | | ATM | EXE-06.03.01-VP-719 | Airport Surface Management Integration | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-758 | Integration of airport safety nets, advanced surface routing in a CWP | | |
| | | | | EXE-06.03.01-VP-761 | Integration of advanced CWP and Surface Management functions - OFA1.2.1, 4.2.1, 6.1.1 | | |
| | | | | EXE-06.09.02-VP-679 | Integration of A-CWP and A-SMGCS Level III/IV | | |

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| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| #26 | Manual taxi routing function | | ATM | EXE-06.03.01-VP-719 | Airport Surface Management Integration | Closed | Results should support R&D in SESAR 2020 PJ.03a-01. Related OI step to be removed from ATM Master Plan |
| #47 | Guidance assistance through airfield ground lighting | | ATM | EXE-06.03.01-VP-759 | Use of AGL as guidance supported by Ground Markers | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-761 | Integration of advanced CWP and Surface Management functions - OFA1.2.1, 4.2.1, 6.1.1 | | |
| #48 | Virtual block control in low-visibility procedures | | ATM | EXE-06.03.01-VP-719 | Airport Surface Management Integration | V3 - TRL6 | Potential SESAR Solution |
| #116 | De-icing management tool | | TECHNO | EXE-06.06.02-VP-513 | De-icing Step 1, DIMT Functionalities in an A-CDM Environment | V3 - TRL6 | Potential SESAR Solution |

**Table 19: SESAR Solution conclusions summary at the completion of Release #5 (2016) for the Key Feature "High-performing airport operations"**

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| #06 | Controlled time of arrival (CTA) in medium-density/medium-complexity environments | | ATM | EXE-05.06.01-VP-477 | i4D Real Time Simulations supporting Step C | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-05.03-VP-805 | Advanced Arrival Management supported by CTA and ASPA S&M (2nd RTS & Live-Trial) | V3 - TRL6 | |
| #08 | Arrival management into multiple airports | | ATM | EXE-05.04.02-VP-778 | Step 1 V3 AMAN into Multiple Airports | V3 - TRL6 | Potential SESAR Solution |
| #09 | Enhanced terminal operations with RNP transition to ILS/GLS | Y | ATM | EXE-06.08.08-VP-787 | V3 - Curved Approach/IGS Flight Trial in Malpensa OFA01.03.01 & OFA02.01.01 | V3 - TRL6 | Potential SESAR Solution |
| #10 | Optimised route network using advanced required navigation performance (RNP) | | ATM | EXE-04.07.03-VP-794 | Gap Analysis of PBN functionality in Optimised 2D/3D Routes | V3 - TRL6 | Potential SESAR Solution |
| #11 | Continuous descent operations (CDO) using point merge | | ATM | EXE-05.06.02-VP-763 | CDO Operations at LFPO | V3 - TRL6 | Potential SESAR Solution |
| #16 | ASAS spacing applications 'remain behind' and 'merge behind' | | ATM | EXE-05.03-VP-805 | Advanced Arrival Management supported by CTA and ASPA S&M (2nd RTS & Live-Trial) | Closed | Benefits not demonstrated |
| #27 | Enhanced tactical conflict detection & resolution (CD&R) services and conformance monitoring tools for en-route | | ATM | EXE-04.03-VP-798 | Free routing and Direct routing environment | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-04.07.02-VP-175 | Project Iteration3: Conflict Detection and Resolution Aid to TC in a STEP1 environment with many evolutive flights (FIR/TMA interface) | V3 - TRL6 | |
| #32 | Free Route through the use of | Y | ATM | EXE-04.03-VP- | Free routing and Direct routing | V3 - TRL6 | Potential SESAR |

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| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | Direct Routing for flights both in cruise and vertically evolving in cross ACC/FIR borders and in high complexity environments | | | 798 | environment | | Solution |
| #33 | Free Route through the use of Free Routing for flights both in cruise and vertically evolving in cross ACC/FIR borders and within permanently low to medium complexity environments | | ATM | EXE-04.03-VP-798 | Free routing and Direct routing environment | V3 - TRL6 | Potential SESAR Solution |
| #113 | Optimised low-level instrument flight rules (IFR) routes for rotorcraft | | ATM | EXE-04.10-VP-815 | | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-04.10-VP-816 | | | |
| | | | | EXE-04.10-VP-818 | | | |

**Table 20: SESAR Solution conclusions summary at the completion of Release #5 (2016) for the Key Feature "Advanced air traffic services"**

| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| #28 | Initial ground-ground interoperability | | TECHNO | EXE-04.03-VP-841 | (V2) IOP-G ATC/ATC Skip ATSU and Point Flight Operations | V2 - TRL4 | Maturity level achieved was TRL-4, as planned. R&D shall continue within SESAR 2020 PJ18.02 |
| #34 | Digital integrated briefing | | ATM | EXE-13.02.02-VP-461 | Digital Integrated Briefing for all phases of flight | V3 - TRL6 | Potential SESAR Solution |
| #35 | Meteorological information exchange | Y | TECHNO | EXE-06.03.01-VP-669 | Close out Airport Integration through SWIM | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.03.01-VP-757 | | | |
| | | | | EXE-06.06.02-VP-513 | De-icing Step 1, DIMT Functionalities in an A-CDM Environment | | |
| | | | | EXE-13.02.02-VP-461 | Digital Integrated Briefing for all phases of flight | | |
| | | | | EXE-13.02.03-VP-700 | Advanced Short Term ATFCM including Network Supervision and interface with Local Tools | | |
| #37 | Extended flight plan | Y | ATM | EXE-07.06.02-VP-713 | EFPL usage in flight planning, DCB and ATC operations. | V3 - TRL6 | Potential SESAR Solution |
| #46 | Initial system-wide information management (SWIM) technology solution | Y | TECHNO | EXE-06.03.01-VP-669 | Close out Airport Integration through SWIM | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-06.09.02-VP-679 | Integration of A-CWP and A-SMGCS Level III/IV | | |
| | | | | EXE-07.05.02- | Real time airspace status data | | |

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| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | | | | VP-710 | exchange | | |
| | | | | EXE-07.06.02-VP-713 | EFPL usage in flight planning, DCB and ATC operations. | | |
| | | | | EXE-11.01.05-VP-789 | Validate State Airspace User Processes in Step 1 Lot #2 | | |
| | | | | EXE-13.02.02-VP-461 | Digital Integrated Briefing for all phases of flight | | |
| | | | | EXE-13.02.03-VP-700 | Advanced Short Term ATFCM including Network Supervision and interface with Local Tools | | |
| | | | | EXE-13.02.03-VP-749 | TTA / TTO Management | | |
| #100 | ACAS ground monitoring system and presentation system | | TECHNO | EXE04.08.03-VP-066 | | V3 - TRL6 | Potential SESAR Solution |
| #101 | Extended hybrid surveillance | | TECHNO | EXE-09.47-VP-821 | | V3 - TRL6 | Potential SESAR Solution |
| | | | | EXE-09.47-VP-822 | | | |
| #102 | Aeronautical mobile airport communication system (AeroMACS) | | TECHNO | EXE-15.02.07-VP-445 | | V3 - TRL6 | Potential SESAR Solution |
| #109 | Air traffic services (ATS) datalink using Iris Precursor | | TECHNO | | | V3 - TRL6 | Potential SESAR Solution |
| #110 | ADS-B surveillance of aircraft | | TECHNO | EXE-06.03.02- | | V3 - TRL6 | Potential SESAR |

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| Solution ref. | Solution name | PCP? | ATM / Technological | Exercise ID | Exercise Name | R5 conclusion | Release 5 recommendation |
|---|---|---|---|---|---|---|---|
| | in flight and on the surface | | | VP-652 | | | Solution |
| #112 | Flexible communication avionics | | TECHNO | | | V2 - TRL4 | Maturity level achieved was TRL-4. Clean Sky 2 has already planned to continue R&D on this concept |
| #114 | Composite surveillance (ADS-B/WAM) | | TECHNO | | | V3 - TRL6 | Potential SESAR Solution |
| #115 | Extended projected profile (EPP) availability on ground | Y | TECHNO | EXE-05.06.01-VP-477 | | V3 - TRL6 | Potential SESAR Solution |

**Table 21: SESAR Solution conclusions summary at the completion of Release #5 (2016) for the Key Feature "Enabling Aviation Infrastructure"**

*Release #5 outcome: the 36 SESAR Solutions proposed to transition to deployment*

**Key Feature "Optimised ATM network services"**
**SESAR Solution #17 - Advanced short-term ATFCM measures (STAMs)**

*Less waiting and fewer delays*

To avoid traffic overload, flights are typically held on the ground rather than added to congested flight paths. These precautionary measures can be imposed hours in advance and are based on flight plans. Short-term air traffic flow capacity management (ATFCM) measures (STAMs) have more flexibility to handle traffic overload since control measures are applied at a later stage and align more closely with actual demand. They also allow additional measures, such as temporarily constraining a flight or group of flights at a lower altitude, or imposing minimum miles-in-trail separation, to prevent sector overload.

SESAR is developing 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 should be possible to target individual flights with a STAM measure, such as a minor ground delay, flight level cap, or minor re-routing, to take into account local preferred solutions, rather than apply a regulation to a group of flights as a whole.

Advanced STAMs include a set of automated support tools at the network level which detect hotspots and disseminate the information to flow management positions in the area control centres. The toolset also includes 'what-if' functionalities to evaluate what the effect of STAMs will be before effectively applying them. The information takes account of an expanded information set including weather, airport operations, runway occupancy and traffic complexity. The data is shared electronically with the opportunity to use business-to-business (B2B) system-wide information management (SWIM) in the future.

SESAR's automated STAM tools allow a shared situational awareness of the STAMs applied across the network for flow management staff, and makes all STAM-related data available for detailed post-operational analysis.

This solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project.

Benefits are:

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

**SESAR Solution #18 - Calculated take-off time (CTOT) and target time of arrival (TTA)**

*Moving to time-based operations*

As the airspace network and the airports become more connected, opportunities open up to smooth traffic flow and prevent imbalances between demand and capacity. This SESAR solution allows more intelligent demand and capacity balancing when traffic demand for landing into an airport exceeds the airport capacity (hotspot), by allowing the arrival airport to participate in the decision-making process of how to resolve the situation.

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 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 thereby benefitting passengers and airlines, as well as the network.

Another aspect of this SESAR solution is based on a greater level of information sharing between the Network Manager and flight operators. Whenever a flight is issued with a regulated take-off time, the airline also receives from the Network Manager the corresponding target time to arrive at the capacity-constrained area that motivated the regulation of its departure time. While target times are hard constraints, it is expected that the shared awareness will increase the effectiveness of air traffic flow management regulations. During the flight, any deviations between the agreed targets and the actual flight may be used by the different partners (flight crew, aircraft operator, local traffic managers) to support adherence to the time of entry in the congested area(s) and/or to assess and monitor the effects of deviations.

Live trials are testing the concept to validate its feasibility with input from all actors involved. The trials include communicating planned measures (such as take-off and arrival time) as well as tactical measures imposed to maintain planned performance. The trials are also testing the use of sharing the same network view of the situation.

This solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project.

Benefits are:

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

## SESAR Solution #19 - Automated support for traffic complexity detection and resolution

### *Better tools for complexity resolution*

Air traffic control uses flight plan data filed by airlines - indicating the routes they intend to fly - to safely and efficiently manage the airspace. Reality, however, can vary from planned operations, as aircraft encounter unexpected delays, weather disruption or can be re-routed to avoid bottlenecks. Providing local flow management positions (FMP) with more accurate information about traffic flow, as well as tools to predict complexity and traffic peaks, offers a more efficient way to reduce airspace complexity.

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.

The complexity assessment and resolution (CAR) tool operates in short-term and medium-term time horizons to balance workload across different sectors to maximise throughput without overloading or leaving airspace capacity unused. CAR is supported by automated tools which take into account the availability of airspace (due to weather, reservation, etc.), sector capacity, operator preferences and overall network operations. Resolution of complexity problems requires the combination of automated detection tools and flexible deployment of human resources to ensure high levels of efficiency are sustained. It supports FMPs and supervisors in better tactical decision making, and delivers more predictable traffic flow.

Real-time simulations are being carried out to test the automation tools in the en-route environment, and the extended arrival manager time horizon. Further real-time simulations are assessing the concept of complexity measurement in a free route environment. The aim is to simplify the air traffic situation and enable controllers to optimise throughput with very little intervention.

This solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project.

Benefits are:

- Increased ATC capacity
- Improved punctuality
- Increased cost efficiency
- Enhanced safety
- Reduced fuel and emissions

**SESAR Solution #20 - Initial collaborative network operations plan (NOP)**

*Sharing information in real time*

The network operations plan (NOP) is a single window showing information in real time about the air traffic situation across the whole of Europe. Through the NOP, air navigation service providers, airlines, ground handlers, meteorological experts and airports can view the current situation and can coordinate their activities. Importantly, it connects the airports with the rest of the system by including capacity and operational data and shows where any likely pinch points might occur.

The SESAR Solution is extending 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.

Live trials in different locations are looking at the feasibility and benefits of expanding the collaborative aspects of NOP, and the integration AOP-NOP, specifically by assessing the safety and technical feasibility of automatically updating controller displays when airspace users activate temporary airspace reservations in military airspace. The exercises aim to identify the interoperability requirements between air traffic control, airspace users and the Network Manager.

Meanwhile, a series of shadow-mode exercises are evaluating the use of the information sharing environment for assessing the impact of advanced short-term air traffic flow capacity management (ATFCM) measures (STAMs) on network performance. The exercises are also validating the integration of weather information into the network - including meteorological forecasts - to improve tactical demand capacity balancing measures.

This solution is in the pipeline for delivery. Validation exercises are testing the operational feasibility of decision making based on data exchange in real time. The solution will be deployed across Europe in accordance with the Pilot Common Project.

Benefits are:

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

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## SESAR Solution #31 – Variable profile military reserved areas and enhanced civil-military collaboration

### *Advanced flexible use of airspace*

Traditional airspace classification of certain areas for either 'civil' or 'military' use has been superseded by the concept of flexible airspace use which allows the airspace to be allocated according to user requirements. The concept is achieved through enhanced civil/military coordination and plays a major role in delivering additional airspace capacity. However, its application is still largely confined to national airspace use rather than cross-border implementation, a situation that SESAR is working hard to change.

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.

Live trials are demonstrating the feasibility of automatically updating airspace status into the Network Manager system, and assessing the optimum technology solution that can put into an operational environment. The activities will help to refine the interoperability requirements so there is better exchange of data between the different parties. A series of shadow-mode trials are also taking place to validate the benefits of sharing and using aeronautical information for mission-planning purposes.

SESAR has validated the advanced flexible use of airspace in terms of connectivity using basic procedures and systems with limited functionality. SESAR's work is now concentrating on refining those procedures and further developing the functionality of the systems space. The solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project.

Benefits are:

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

**Key Feature "High-performing airport operations"**
**SESAR Solution #01 – Runway status lights**

*Visual signals to safeguard runway users*

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 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 the instant a potential incursion is detected by the A-SMGCS.

The RWSL are unique in providing instant visual alerts, and operate simultaneously with, and in addition to, other safety nets such as on-board alerts and air traffic control safety nets. The system improves awareness of runway usage, and reduces the risk of runway incursions. It applies equally to aircraft and vehicle traffic and does not require additional equipment in the cockpit or driver's cab.

This solution is in the pipeline for delivery.

Benefits are:

- Enhanced runway safety
- Increased situational awareness

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## SESAR Solution #02 - Airport safety nets for controllers: conformance monitoring alerts and conflict detection

### *Enhancing safety at busy airports*

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 simulations to see how various tools can operate together to provide integrated airport safety nets. These simulations 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 cleared route deviation by aircraft.

The introduction of electronic flight strips in many control towers means that instructions given by a controller are available electronically and can be integrated with other data such as flight plan, surveillance, routing and published rules and procedures. The integration of this data allows the system to monitor the information and alert the controller when inconsistencies are detected. This solution highlights potential conflicts much sooner than the current practise of relying on surveillance data to trigger an alarm. Taxi route deviations are among the most common alerts at large busy airports, but all alerts improve safety.

This solution is in the pipeline for delivery. Airport safety nets are due for synchronised deployment across Europe in accordance with the Pilot Common Project.

Benefits are:

- Increased situational awareness
- Improved safety on and around the runway

**SESAR Solution #04 - Enhanced traffic situational awareness for vehicle drivers**

*Providing vehicle drivers with enhanced visual tools*

Driving an airfield vehicle around the airport should be straightforward in normal operational conditions. But how do you ensure you are following the correct route when in dense fog, or at night, or when an unforeseen event occurs? And more importantly, how do you ensure that you are not entering a safety critical area without a clearance, putting you and the other mobiles' safety at risk?

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 controller's surface guidance system.

The trials confirmed 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.

This solution is in the pipeline for delivery.

Benefits are:

- Increased situational awareness
- Increased safety on and around the runway

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## SESAR Solution #12 – Single remote tower operations for medium traffic volumes

### *Remote tower services benefit medium sized airports*

Conventional control towers are expensive to operate and maintain, and even at a medium-sized airport can become too costly if the number of flights is insufficient to cover the running costs. SESAR's remote tower services offer the possibility to enhance safety and efficiency at airports where it is too expensive to build, maintain and staff conventional tower facilities and services. The solution is already deployed at small airports, and is under test at medium-sized airports.

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 pantilt-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.

Shadow-mode exercises used a video-based panorama camera system as well as infrared technology to give controllers a detailed view of the airfield. The tests provided enhanced views of the airfield and terminal area, even during adverse weather conditions and at night. Single airport operations will apply in each case, but controllers will have the option to cross-train for more than one airport.

This solution is in the pipeline for delivery.

Benefits are:

- Increased cost
- Efficiency

**SESAR Solution #13 – Remotely-provided air traffic services for contingency situations at aerodromes**

*Providing back-up remotely*

Security alerts can shut down control towers. How does the airport ensure minimum disruption in an emergency? This question has been addressed by SESAR looking at contingency situations for airports.

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. Shadow-mode exercises have been carried out to examine exactly how a remote tower facility can provide contingency services at medium-sized airports. The exercises assessed the transition time necessary to switch from the primary tower to the contingency facility, what level of service can be provided in the absence of an out-of-the-window view, and what information can be accessed by controllers. They also looked at controller workload, situational awareness, and human performance.

This solution is in the pipeline for delivery.

Benefits are:

- Increased cost efficiency
- Improved resilience in degraded situations

## SESAR Solution #21 - Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP)

### *Airports are the nodes of the network*

Airports are the nodes of the airspace network, linking flights for seamless traffic flow. They can also act as bottlenecks of the network and need to be integrated into the system as a whole. The network operates according to a pre-defined network operations plan (NOP), so why not airports? SESAR is introducing the additional means to manage airport operations in a collaborative and proactive way, through the airport operations plan (AOP) and the airport operations centre (APOC).

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. Four principle tasks are covered in these solutions: to establish performance goals, to monitor these goals, to take action if performance deviates, and to provide feedback and analysis on actions taken.

Ultimately, the AOP and APOC make airports more resilient to disruptions, allowing a more efficient management of airport demand capacity balancing and operations such as de-icing. SESAR validations looked in detail at information requirements, alerts and information sharing in order to optimise runway use during capacity-constrained situations. Real-time simulations as well as shadow-mode exercises were used to validate airport performance monitoring and management. Finally, a live trial took place using a de-icing management tool to review performance in winter conditions.

In 2014, London Heathrow and Paris Charles de Gaulle partially implemented the solution. The full solution is in the pipeline for delivery and synchronised deployment is planned as part of the European Commission's Pilot Common Project.

Benefits are:

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

**SESAR Solution #22 – Automated assistance to controllers for surface movement planning and routing**

*Efficient planning around the airport*

Selecting the most suitable route from the departure gate to the runway 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 planner 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. It also calculates the taxi time, which can then be used for departure planning purposes. The controller can graphically edit the route before relaying it to the pilot by voice, or where possible by datalink.

By generating an electronic route plan, the information can be shared not just with the cockpit, but also with the airline operations centre, air traffic control and other operators on the airfield. It is less prone to error than route plans agreed solely based on controller/pilot communication, and it increases air navigation service productivity. The route plan is also available for use with other solutions such as enhanced guidance assistance tools (cockpit display system or airport moving map) to provide guidance instructions for pilots or vehicle drivers on the airfield.

Trials revealed a reduction in variability between the planned and actual taxi time compared with manual routing. Efficiency of surface operations is also improved since pilots and vehicle drivers can receive optimum route plans. Safety and capacity are also enhanced as a result of more predictable operations.

This solution is in the pipeline for delivery. The solution is due for synchronised deployment across Europe in accordance with the Pilot Common Project.

Benefits are:

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

**SESAR Solution #23 - D-TAXI service for controller-pilot datalink communications (CPDLC) application**

*Improved communications thanks to datalink*

Radio channels become congested and hard to access during busy departure times. Yet the majority of transmissions are routine exchanges between the controller and the flight deck to confirm instructions such as pushback clearance, start-up and taxi instructions. Datalink provides a more efficient means to relay these messages and is less prone to error.

Aircraft already use datalink in oceanic airspace to send position updates and request route changes, and the technology even now delivers pre-departure instructions to pilots at the gate. 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 of planned and cleared departure routes by datalink 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 critical clearances like line-up and take-off.

A combination of simulations and live trials assessed the performance of the solution in different traffic densities, with different levels of aircraft equipage. Datalink messages were exchanged to initiate start-up, push back, taxi, revised taxi and further route information (such as de-icing). The exercises also used SESAR routing and planning functions to obtain the most suitable taxi route. The activity aims to improve the predictability of surface movements.

This solution is in the pipeline for delivery.

Benefits are:

- 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
- Reduced fuel burn and emissions

**SESAR Solution #47 - Guidance assistance through airfield ground lighting**

*Follow-the-greens*

Airfield ground lighting offers a unique opportunity to guide aircraft 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 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 as the aircraft moves along its assigned route. Stop bars are automatically activated at no-go areas, and the pilot simply receives a single instruction to 'follow-the-greens'. The activity also relies on the surface movement guidance and control system to provide accurate aircraft position data.

The solution improves the safety of surface operations, especially during low‑visibility conditions, through a reduction of runway incursions, taxi route deviations and holding position overruns. It increases situational awareness and improves the predictability of surface movement through a reduction in the variability of taxi times. The fewer speed changes also result in lower fuel consumption.

SESAR validations have used a combination of simulation exercises, shadow-mode trials using vehicles to represent aircraft and several live trials with commercial aircraft. In all cases, the trials showed that the use of the lighting system can significantly help to reduce taxi times and also reduce the duration of stops during taxiing, improving efficiency. Fewer radio transmissions were required, freeing up controllers' time for other tasks. Based on more than 650 movements, one of the airports at which the solution was validated recorded a 25 % reduction in taxi time, while radio transmissions fell by the same amount. Clearance delays (the time between the pilot's push back request and actual clearance) fell by two thirds.

This solution is in the pipeline for delivery.

Benefits are:

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

## SESAR Solution #48 – Virtual block control in low‑visibility procedures

### *Enhancing safety with virtual stop bars*

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, 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 help the ground controller provide 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. Similarly, for aircraft equipped with datalink, the location of virtual stop bars can be uplinked to the airport moving map. 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 and improves predictability of surface movements. Taxi times improve and variability are reduced in low‑visibility conditions, thereby reducing fuel burn and emissions.

Real time simulations tested the solution using datalink communications with aircraft as well as airfield vehicles.

This solution is in the pipeline for delivery.

Benefits are:

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

**SESAR Solution #116 - De-icing management tool**

*Improved winter weather forecasting for de-icing operations*

The winter season at European airports can last from a few days to many months and during this time de-icing services may need to be provided. The procedure of applying required de-icing fluids to aircraft at most airports is primarily a business process that takes place between an airline and a specialised ground handling agent. 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.

The DIMT allows for the scheduling and monitoring of de-icing operations. It is an internet browser-based tool that addresses three distinct procedures for de-icing:

- Remote de-icing, which occurs at a specific location on the airport away from the parking stand;
- On-stand de-icing, which occurs just before the aircraft leaves its stand; and
- After-push de-icing, which occurs after the aircraft has pushed back from the stand and is positioned to start taxiing after de-icing.

The tool has two key functions, the first of which is to accurately estimate the duration of the de-icing and/or anti-icing procedures for a given airframe. This elapsed time is dependent on three parameters: the aircraft type, the prevailing weather conditions at the airport during the aircraft's visit and the number of de-icing rigs used for the application of de-icing and anti-icing fluids.

The second function is to calculate a de-icing sequence that optimises available resources and allocates them to slots in a timeline while taking into account the constraining variables that limit how the problem can be optimised. For on-stand and after-push operations de-icing rigs are assigned to these slots, while remote de-icing considers the track availability at the designated location, i.e. the de-icing pad.

The de-icing coordinator and the de-icing agent can refine the sequence through the DIMT user interface to account for any ad hoc situations that are not handled by the tool.

The DIMT produces estimated de-icing time (EDIT), estimated commencement of de-icing time (ECZT) and estimated end of de-icing Time (EEZT) time stamps and publishes these to the A-CDM platform, both improving the quality of de-icing milestone information and increasing common situational awareness for other airport actors.

The tool was validated during a series of exercises, which took place in Helsinki, Oslo and Stockholm airports during late 2015 and early 2016. The focus of the exercises was to analyse the impact of a planning phase for de-icing operations on the predictability of the air transit view (ATV) through the introduction of a de-icing management tool (DIMT). With the involvement of airport operations data

base (AODB), the DIMT subscribes to flight information and produces information in the form of time stamps for use by coordinators, managing the de-icing of aircraft.

This solution is ready for industrialisation.

**Key Feature "Advanced air traffic services"**

**SESAR Solution #06 – Controlled time of arrival (CTA) in medium-density/medium-complexity environments**

*Airborne technology aids arrival sequence*

Building an arrival sequence in medium- and high-density environments calls on controller resources from an early phase in the approach procedure. The process is predominantly ground-based and can result in late vectoring and unnecessary holding rather than fuel-efficient strategies based on en-route speed management for efficient delay absorption. By combining time management capabilities on board aircraft with ground-based system support, the arrival management process can be more predictable and deliver more efficient operations.

Controlled time of arrival (CTA) is a time constraint defined by air traffic control that allows an aircraft to self-manage its speed in order 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, the flight management system will optimise the flight speed according to aircraft type and wind conditions.

SESAR is testing how CTA operations can be applied in medium-density and complex terminal airspace. Many aircraft are already equipped with flight management systems that support flying to a time constraint through the use of the required time of arrival (RTA) airborne function. Adding the procedure to the arrival management process will contribute to more stable arrival sequences at an earlier stage, and reduce the environmental impact. Integration of this solution with other solutions, such as extended arrival management (E-AMAN) and/or airborne sequencing and merging, is under validation to consolidate a larger set of benefits in the arrival queue management operations.

This solution is in the pipeline for delivery. Further work is planned in particular to consolidate the results and requirements to support implementation.

Benefits are:

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

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## SESAR Solution #08 – Arrival management into multiple airports

### *Streamlining traffic flow into multiple airports*

Some airports in Europe are located very close to one another, which means that they must share the surrounding airspace, or terminal manoeuvring area. However, in today's air traffic management, airports are considered as separate entities rather than integrated nodes in a wider network. As a result, aircraft cannot always access the most efficient routes in terminal airspace.

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 in order to calculate the most efficient arrival streams.

This solution looks at converging arrival streams, and spacing the aircraft to optimise traffic flow in order to reduce the need for tactical interventions by controllers. By imposing a time-to-lose (TTL) constraint, aircraft can be sequenced efficiently in the extended terminal area, reducing the need for subsequent radar-vectoring. The aim is to establish a new multi-airport arrivals concept that is expected to increase air navigation service efficiency, in particular the use of tactical voice communications, and deliver more fuel-efficient arrival streams.

The solution offers the most benefit in more complicated terminal airspace, where airports already use arrival management tools to smooth queues. A series of real-time simulations looked at converging arrival streams, spacing aircraft to optimise traffic flow in order to reduce the need for tactical interventions by controllers. The validation exercises also assess training and staffing requirements.

This solution is in the pipeline for delivery.

Benefits are:

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

**SESAR Solution #09 – Enhanced terminal operations with RNP transition to ILS/GLS**

*Flexible arrivals and departures*

The focus on efficient, green operations at European airports has led to the development of more flexible arrival and departure routes which take advantage of the satellite-based navigation capability on board modern aircraft. This solution refers to the use of curved procedures enabled by advanced required navigation performance (RNP) with a transition to ILS/GLS. This allows aircraft to follow new approach paths, for example to avoid noise emissions over populated areas, reduce track miles, and add new flight paths, while also achieving ILS landing guidance to low-minima of 200 ft. and below.

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.

Flight trials were carried out to validate new arrival procedures based on the use of different glide path angles for two arriving aircraft aiming at different touchdown zones on the runway to reduce the risk of wake encounter. The exercise sets out to confirm the operational feasibility of the procedure, including its impact on the situational awareness of controllers and pilots.

This solution is available for industrialisation and is due to be implemented across Europe in accordance with the Pilot Common Project.

Benefits are:

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

## SESAR Solution #10 – Optimised route network using advanced required navigation performance (RNP)

### *Designing more efficient airspace*

New possibilities in advanced airspace design solutions and options are now possible thanks to the precision in airborne navigation using the improved navigation performance provided by required navigation performance (RNP) on board modern aircraft. This solution supports connectivity between free route airspace and TMAs thanks to advanced RNP below flight level 310.

Aircraft with RNP specifications are equipped with on-board performance monitoring and alerting to continually check conformance. 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).

One of the main benefits provided by A-RNP is the potential to increase the overall efficiency of the air traffic management system, as a result of the greater flexibility of airspace design. This allows, for example, being able to place flight paths, arrival and departure routes, in the most convenient place. The predictable turn performance inherent in A-RNP in en-route and terminal airspace also makes it possible - due to enhanced track keeping in the turn - to place routes where they cannot necessarily be placed today using less advanced navigation capabilities.

The solution is available for industrialisation.

Benefits are:

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

**SESAR Solution #11 – Continuous descent operations (CDO) using point merge**

*Smoother, quieter, and more efficient*

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 could follow a single air navigation trajectory (RNAV) procedure to intercept the instrument landing system (ILS). This enabled pilots to select the optimum descent path, as calculated by the on-board flight management computer, based on aircraft type, load, and wind speed. This also allows for multiple CDOs to be carried out for smoother, quieter descents to the runway.

CDOs are an example of a 'win-win' solution since no levelling off is needed, aircraft burn less fuel. They also can climb much higher thereby reducing the noise impact for the areas below. Initial results showed that noise levels for inhabitants living near the airport changed as controllers were able to disperse arrival paths and positioned the RNAV trajectory away from populated areas. This data is collected using a series of noise stations placed under the arrival paths to test the noise impact of the traffic before and after the flight trials.

This solution is in the pipeline for delivery.

Benefits are:

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

## SESAR Solution #27 – Medium-term conflict detection (MTCD) and conformance monitor tools

### *Keeping ahead of traffic with advanced controller tools*

Providing controllers with improved coordination tools is key to meeting Single European Sky performance targets, which aim to triple airspace capacity. SESAR is supporting development of functions to aid capacity and safety.

Earlier, more reliable and accurate conflict detection leads to better decision making and fewer tactical interventions by controllers. This SESAR solution proposes features specific to the planner controller (PC) or to the tactical controller (TC) in order to cover their specificities when managing high-complexity airspace operations in the en-route environment. The solution focuses on conflict detection aids to TC/PC showing all detected conflicts that would result in a conflict if the controller does not initiate an action, in particular the monitoring aids (MONA) service and the what-else probing (WeP). These tools optimise air navigation service productivity.

A series of real-time simulations are being used to validate tactical and deviation trajectory, 'what-if' and 'what-else' probes, medium-term conflict detection (MTCD), and MONA functionalities.

Real-time simulations are assessing the operational acceptability of automated tools in a free route environment, including a conflict detection function which identifies conflicts up to 20 minutes in advance, called conflict organiser and signaller (COS). Within these exercises, assessments will be made on how flight trajectory sharing can improve the coordination of tasks and controller assistance services between ground control centres.

The SESAR work focuses on the distribution of tasks between planner and tactical controllers, and how the tools are integrated into the decision-making process. The more advanced tools rely on an aircraft's 4-dimensional (4D) trajectory prediction capability, and their synchronisation with route clearances issued from the ground. This includes the exchange of 4D clearances and intent information such as lateral, longitudinal, vertical speed and time constraints.

This solution is in the pipeline for delivery.

Benefits are:

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

**SESAR Solution #32 – Free route through the use of direct routing**

*More direct routes for cross-border operations*

Under the current network structure, aircraft fly an average of 20 km further than the most direct route between two points. This SESAR Solution represents a step forward with respect to the user-preferred routing solution. It offers more direct flight planning route options on a large scale, crossing flight information regions and national borders.

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.

Published direct routes are established within local and regional documentation and then made available for flight planning. SESAR continues to support validation activities to assess the operational acceptability of cross-border direct routing operations.

This solution is in the pipeline for delivery and is due for implementation across the whole of Europe's upper airspace in accordance with the Pilot Common Project.

Benefits are:

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

## SESAR Solution #33 – Free routing for flights both in cruise and vertically-evolving above a specified flight level in low-to-medium density airspace

### *Europe-wide free routing*

Free routing corresponds to the ability of the airspace user to plan and re-plan a route according to the user-defined segments within free route airspace (FRA), where advanced flexible use of airspace (AFUA) principles provide the necessary airspace flexibility. This solution allows airspace users to plan flight trajectories without reference to a fixed route network or published direct routes within low-to medium complexity environments.

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.

The validation activities for this solution included real-time simulations to assess the operational acceptability of free routing. The exercises compared service provision when dealing with free routing and direct routing traffic to assess what is required and acceptable and the likely benefits. The work also looked at airspace complexity and considered operational issues related to military airspace zones in a free routing environment.

This solution is in the pipeline for delivery and is due to be deployed across the whole of Europe's upper airspace in accordance with the Pilot Common Project.

Benefits are:

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

**SESAR Solution #113 – Optimised low-level instrument flight rules (IFR) routes for rotorcraft**

*Enabling rotorcraft operations in busy airspace surrounding airports*

Due to their different operational characteristics to fixed-wing aircraft, especially their lower speed and vulnerability to bad weather, rotorcraft operations inside controlled airspace and terminal manoeuvring areas (TMA) is often limited to visual flight rules (VFR) flights in visual meteorological conditions (VMC). Flights under instrument flight rules (IFR) are often severely constrained or even prohibited altogether. The introduction of IFR procedures specifically designed for rotorcraft enables their safe integration into controlled airspace without adversely affecting existing fixed-wing operations.

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.

Provision of the IFR routes in controlled airspace procedurally separates rotorcraft and fixed-wing traffic. The integration of an optimised low-level IFR route network for rotorcraft can enhance flight safety and weather resilience of rotorcraft operations. Benefits for the environment may also be expected fewer VFR flights at very low altitude and avoidance of noise-sensitive areas thanks to narrow and/or curved low-level procedures.

These low-level IFR routes can be directly linked to dedicated point-in-space (PinS) arrival and departure procedures, where published, enabling simultaneous non-interfering (SNI) operations that are procedurally segregated from conventional fixed-wing operations.

Dedicated low-level IFR routes for rotorcraft not only improve safety, equity and accessibility in the airspace inside the TMA, but may also increase TMA capacity.

Benefits are:

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

## Key Feature "Enabling Aviation Infrastructure"
## SESAR Solution #34 – Digital integrated briefing

### *The benefits of digital data*

The current pre-flight briefing for the pilot includes pages of information, called notice to airmen (NOTAM), recent weather reports and forecasts (MET), which have to be integrated into a consolidated operational picture. The documents can be difficult for pilots to use, and no longer satisfy today's air traffic needs for timely and accurate aeronautical and meteorological information updates. By introducing digital NOTAM and MET data, the briefing could be radically improved.

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.

SWIM information exchange and digital NOTAMs can support the graphical representation of data such as meteorological charts, as well as increase the usability of briefing material by making it searchable and interactive. The digitised information can also be validated and cross-checked automatically (unlike today's pre-briefing documents) to ensure adherence to ICAO standards and to reduce risk of error. In addition, relevant information can be selected more easily from digital data compared with briefing notes which may include between 10 and 50 pages for a cross-European flight.

Real-time simulations are assessing enhancements in pilot briefing applications based on digital NOTAMs, digital MET, and air traffic flow management data, with the aim of improving situational awareness for pilots and reducing briefing times.

In terms of benefits, the graphical presentation of digital information, better filtering and a more logical organisation of the pre-flight information bulletins can improve pilot and dispatcher awareness, reduce briefing times and reduce the risk of information being misunderstood or missed.

This solution is in the pipeline for delivery.

Benefits are:

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

**SESAR Solution #35 – Meteorological information exchange**

*Staying ahead of the weather*

Bad weather brings unwelcome disruption to flight schedules and is the cause of approximately 13 % of Europe's primary delays. Yet the impact can be mitigated by the timely sharing of information so that effective recovery strategies can be put in place.

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.

SESAR is developing a mechanism by which meteorological data generated by European meteorological agencies can be seamlessly integrated into aeronautical information service provision; this is known as the four-dimensional (4D) weather cube. The 4DWxCube is a (virtual) repository of shared consistent and translated meteorological information, produced by multiple meteorological service providers (METSPs) and made available to airspace management stakeholders via its system-wide information management (SWIM) compliant MET-GATE.

Sharing this weather information and its integration within the air traffic management decision-making process enables airspace users, airports and air navigation service providers to stay up to date with the latest weather situation, and to plan accordingly and effectively. Weather conditions influence all aspects of air traffic operations, for example by increasing or decreasing tailwind, by changing pressure or temperature or by introducing low-visibility conditions.

The meteorological information exchange uses SWIM to enable seamless interchange of meteorological data with different partners, and involves SWIM-compliant services such as legacy forecasts (METAR/TAF/SIGMET) and new ones such as hazardous weather (convection, turbulence, icing) developed under the scope of this solution.

This solution is in the pipeline for delivery. MET information exchange will be deployed as part of initial SWIM, in accordance with the Pilot Common Project.

Benefits are:

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

## SESAR Solution #37 – Extended flight plan

### *Improved planning thanks to enriched data*

Air navigation service providers use aircraft flight plan data to plan and schedule air traffic in order to balance airspace supply and demand. In Europe's future trajectory‑based flight environment, where aircraft can fly their preferred flight paths without being constrained by airspace configurations, flight plan data will include additional information, which will allow both the Network Manager and the air traffic control units to have a more precise plan of how the aircraft will fly.

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.

The EFPL includes further information relevant to each point of the aircraft's trajectory, for example speed and aircraft mass, as well as other performance data such as planned climb and descent profiles. This allows both air traffic control and the Network Manager to improve their prediction of the trajectory. This is especially relevant in complex airspace, because it allows better flow management, and also improves the performance of the conflict detection and resolution tools used by controllers.

The EFPL aims to reduce flight plan rejections and increase traffic predictability. Concerning the flight plan rejections, the use of 15 data fields in the ICAO flight plan is open to different interpretations resulting in unwarranted flight plan rejections. The validation of this SESAR solution has included the refinement of the data exchange processes and shows that EFPL significantly reduces flight plan rejections compared to those associated with the ICAO 2012 flight plan validation process.

The solution is in the pipeline for delivery. The extended flight plan is due to be deployed in Europe in accordance with the Pilot Common Project.

Benefits are:

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

**SESAR Solution #46 - Initial system-wide information management (SWIM) technology solution**

*Learning to SWIM*

SESAR is introducing a new approach to sharing information, called system-wide information management (SWIM). SWIM enables seamless information data access and interchange between all providers and users of air traffic management data and services.

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.

This SWIM technological solution provides a coherent set of specifications to support standardisation in the context of SWIM deployment. These are the key elements in steering SWIM-enabled systems for ensuring interoperability as follows:

- Aeronautical information reference model (AIRM) to ensure semantic interoperability;
- Information service reference model (ISRM) to ensure organisational interoperability;
- SWIM technical infrastructure (SWIM TI) profiles and architecture to enable technical interoperability;
- SWIM registry to improve the visibility and accessibility of ATM information and services available through SWIM. It enables service providers, consumers, and the swim governance to share a common view on SWIM providing consolidated information on services that have been implemented based on SWIM standards.

This solution is the pipeline for delivery and is due to be deployed in Europe, in accordance with the Pilot Common Project. The first SWIM-enabled solution was introduced in 2014 to support the exchange of data between neighbouring airspace sectors.

Benefits are:

- Increased cost efficiency and easily accessible information sharing
- Improved service operation

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**SESAR Solution #100 – ACAS ground monitoring system**

*Visualising airborne alerts from the ground*

The airborne collision avoidance system (ACAS) provides resolution advisories (RAs) to pilots in order to avoid collisions. Controllers rely on pilots to report RAs by radio as they occur in accordance with ICAO regulations. However these reports can come late, incomplete or are absent in some instances. This solution consists of a set of monitoring stations and a server system, which enable the continuous monitoring and analysis of ACAS RAs and coordination messages between airborne units from the ground.

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.

A test platform was used to monitor the entire upper airspace during a period of more than three years to collect data and evaluate the concept. The system was able to process and deliver valid resolution advisories within two seconds, and was able to filter out false advisories.

The SESAR validation work also showed that the fusion and the use of surveillance sensor data from Mode-S radar, wide area multilateration (WAM), multilateration (MLAT) and ADS-B, when combined with ACAS ground sensor RA data provide practical and beneficial safety enhancements.

This solution is in the pipeline for delivery. Further work is expected to address the operational use by controllers.

Benefits are:

- Enhanced safety

**SESAR Solution #101 – Improved hybrid surveillance**

*Spectrum efficient surveillance*

The traffic alert and collision avoidance system (TCAS) is an airborne collision avoidance system designed to reduce the incidence of mid-air collisions between aircraft. Currently, TCAS II is dependent upon 1090 MHz replies that are elicited by 1030 MHz interrogations. These provide the pilot with information about the relative distance, bearing and aircraft altitude and are used to build active tracks. However, the process uses precious frequency bandwidth that is also needed for surveillance purposes.

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 the usage of the 1090 MHz frequency.

Validations carried out using roof-top antennae in the proximity of an airport showed the basic functionality of the system. The concept was also flight-tested and this data was used in simulation activity to assess the results and overall impact on 1090 MHz load. The technology met the minimum operating requirements developed for the solution and resulted in no operational differences for pilots and controllers. When the 1090 MHz usage was compared with TCAS II, the assessment showed a reduction of Mode-S interrogations of at least 70 %.

This solution is in the pipeline for delivery.

Benefits are:

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

## SESAR Solution #102 – Aeronautical mobile airport communication system (AeroMACS)

### *Entering the new digital environment*

ATM communications capacity is reaching saturation in Europe due to increasing air traffic volumes and density. The situation is particularly acute on the airport surface where a large concentration of aircrafts combined with pre-flight and post-flight operations increasingly rely on data communications.

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. AeroMACS is an international standard and supports globally harmonised and available capabilities according to ICAO Global Air Navigation Plan (GANP).

SESAR validated the system concept and usage of the airport surface datalink system. This has been done through simulations, developing prototypes and testing in lab conditions as well as on-site at airports and on aircraft. In addition, SESAR led the development of standards in ICAO, EUROCAE/RTCA and the Airlines Electronic Engineering Committee (AEEC). Together with other FCI solutions, AeroMACS will support the multilink FCI concept, offering increased robustness of datalink operations and thereby supporting the move towards the use of datalink communications as the primary means of communications in airspace management.

This solution is in the pipeline for delivery. Implementation will be subject to the demonstration of a viable business case.

Benefits are:

- 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

**SESAR Solution #109 – Air traffic services (ATS) datalink using Iris Precursor**

*A new generation of satellite-based datalink communications*

The Iris Precursor offers a viable option for air traffic services (ATS) datalink using existing satellite technology systems to support initial four-dimensional (i4D) datalink capability. The technology can be used to provide end-to-end air–ground communications for i4D operations, connecting aircraft and air traffic management ground systems.

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.

A SESAR flight trial demonstrated that the Iris Precursor service could provide the communication performance required for datalink exchanges to fly i4D operations. Specifically, it showed how i4D automatic dependent surveillance-contract (ADS-C) could be successfully maintained with two air traffic control centres for over two hours. During this time, i4D ADS-C reports were generated on events resulting in downlinking trajectory updates approximatively every 20 seconds with 20 waypoints - an update rate which is well above the rate needed for i4D trajectory exchanges. In addition to the i4D trajectory exchanges, various controller-pilot datalink communications (CPDLC) messages were exchanged along the flight with a remarkable performance round trip time of below two seconds throughout the flight's duration.

This solution is in the pipeline for delivery. The transition roadmap from Iris Precursor to the future communication infrastructure is currently being addressed by SESAR 2020 - the next wave of research and innovation activities by the SESAR JU - as well as by the European Space Agency (ESA) and Inmarsat (Iris Service Evolution).

Benefits are:

- Enabler for initial i4D operations

## SESAR Solution #110 – ADS-B surveillance of aircraft in flight and on the surface

### *Improving surveillance security and integrity*

Automatic dependent surveillance-broadcast (ADS-B) is a technique which allows the tracking of aircraft in flight and on the surface. Enhancements of functionality and interfaces are required to the ground surveillance system, in order to make it compliant with the new applications of ADS-B in radar airspace, ADS-B for airport surveillance and other emerging requirements, such as security.

The SESAR solution consists of the ADS-B ground station and the surveillance data processing and distribution (SDPD) functionality. The solution also offers 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.

Shadow-mode exercises showed how the solution can be used in different types of airspace (airports, TMA, en-route) under nominal and non-nominal conditions and can be used to improve flight conformance monitoring. The solution is seen as a key enabler for surveillance infrastructure rationalisation thanks to the efficiency gains it brings in terms of costs and spectrum usage. The solution is also fully interoperable with other surveillance means and derives synergies.

This solution is in the pipeline for delivery.

Benefits are:

- Enabler for surveillance infrastructure rationalisation

**SESAR Solution #114 - Composite cooperative surveillance automatic dependent surveillance – broadcast/Wide area multilateration (ADS-B/WAM)**

*Combining surveillance systems for greater efficiency*

Composite cooperative surveillance ADS-B/WAM is a system that exploits the similarities between the two surveillance techniques and combines them into a single system. ADS-B information received by WAM system is evaluated and if matching with WAM information extracted by others methods, then it is used in the WAM output. Information is then periodically re-evaluated.

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.

Since the two surveillance layers share hardware components, the system offers improved cost efficiency. Furthermore, the use of the system contributes to an improved security by successfully mitigating associated ADS-B threats.

SESAR has contributed to the relevant standards, such as EUROCAE technical specifications for WAM and ADS-B that are implementing this "composite" concept.

Shadow-mode exercises demonstrated that use of ADS-B data in the WAM output helps to reduce the RF pollution generated by the system. Platforms were used to collect a large dataset of overlapping CAT021 ADS-B and CAT020 WAM messages and assessed to compare WAM & ADS-B values.

This solution is available for industrialisation.

Benefits are:

- Improved cost efficiency
- Improved security
- Increased spectrum efficiency

Approved

Founding Members

EUROPEAN UNION    EUROCONTROL

## SESAR Solution #115 - Extended projected profile (EPP) availability on ground

### *Getting connected*

Modern aircraft feature advanced computerised flight management systems (FMS) to guide their navigation, which can exchange relevant data with the airline operations centres (AOC). Air traffic control centres, in turn, have sophisticated flight data processing systems (FDPS) to manage flight data on the ground, but there is limited data connection between the FMS and air traffic control ground systems.

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.

In this initial solution, the ground systems will enable controllers to display the downlinked route on the radar screen and will also automatically cross-check whether the downlinked route is consistent with what was expected on the ground; controllers will receive a warning in case a discrepancy is identified.

This solution is ready for industrialisation. It will be deployed in a synchronised way across 22 air traffic control centres and 18 terminal manoeuvring areas and airports across Europe in accordance with the Pilot Common Project.

Benefits are:

- Increased ground situational awareness
- Increased data connectivity between on-board systems and ground air traffic control systems is a key enabler for the modernisation of the ATM system

## Annex I.2     SESAR 2020

For example: KPI's and SLA's and provisions for performance measurement relating to core business of the Agency

### 1. Strategic Programme Steering

#### PJ.19

SESAR 2020 Project 19 was kicked off in 01 November 2016. In the ramp-up phase of the project it concentrated on two aspects:

- set-up internal organisation and define detailed initial tasks like PJ19 initiated the production of the PMP (D1.1), the definition of the validation targets 2017 (D4.2) and the EATMA Guidance material and support (D5.1).
- support the SJU in the ramp-up of the entire SESAR 2020 programme by contributing (preparing and attending) to a series the first SESAR 2020 Briefing sessions to instruct all SESAR 2020 IR/VLD Projects about how to work.

#### PJ.20

Agreements settlement phase was successfully closed. The kick-off meeting took place in November 2016.

### 2. Exploratory Research

#### Innovative ATM Architecture: ER project 'PACAS'

In Q2 2016, the exploratory project PACAS was kicked off, ramped up and launched in execution.

The PACAS project is about supporting change management in Air Traffic Management (ATM) systems from an architectural point of view, relying on the end-to-end inclusion of ATM domain stakeholders through gamification. The project constructs a platform that facilitates understanding, modelling and analysing changes in the ATM system at different layers of abstraction. To accommodate the expertise of the various domain stakeholders PACAS relies on the provision of multiple views at the strategic layer, in order to represent and analyse different objectives, namely those related to economical, organizational, security, and safety concerns. The PACAC process intends to keep the views, as well as the strategic and architectural layers aligned by finding an optimal solution (trade-off) among the various objectives through a novel participatory design process.

In 2016 the following first results were obtained:

- Identification of state of art modelling techniques for each PACAS perspective, tailoring a separate view per expertise (economics, organisation, security and safety) with the aim of modelling ATM systems to capture strategic objectives of involved domain stakeholders, such as safety, security, and organisational concerns in separate views, emphasizing the sociotechnical nature of ATM systems.
- Identification of state of art reasoning techniques through an in-depth analysis with the aim to allow analysis of strategic objectives from multiple perspectives and the interdependencies between the strategic and functional (operational, service, system) levels to preserve their alignment.

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- Initial Identification of validation strategy and scenarios
- A first version of the participatory design process was delivered. The artefact was based on an extensive and very comprehensible gap analysis performed against and covering:
  - o the design of large scale systems focusing on participatory decision making processes, the role of incentives in these processes also through gamification mechanisms, enterprise architectures (EA) that are the de-facto standard in ATM design, and requirements engineering for socio-technical systems
  - o modelling concepts, focusing on EAs and socio-technical systems modelling for each of the PACAS stakeholder perspectives including economic and organisational, safety and security domains
  - o reasoning techniques, focusing on techniques specifically tailored for each of the PACAS stakeholder perspectives (economic, organizational, safety and security), to then analyse multi-objective reasoning techniques for change management design of large scale systems
- a first definition of a collaborative platform (initial concept through definition of wireframes to showcase)

### *ATM Performance*

### ER project 'INTUIT'

In Q2 2016, the exploratory project INTUIT was kicked off, ramped up and launched in execution.

The goal of INTUIT is to explore the potential of visual analytics, machine learning and systems modelling techniques to improve our understanding of the trade-offs between ATM KPAs, identify cause-effect relationships between indicators at different scales, and develop new decision support tools for ATM performance monitoring and management. The specific objectives of the project are the following:

- to conduct a systematic characterisation of the ATM performance datasets available at different spatial and temporal scales and evaluate their potential to inform the development of new indicators and modelling approaches;
- to propose new metrics and indicators providing new angles of analysis of ATM performance;
- to develop a set of visual analytics and machine learning methodologies and algorithms for the extraction of relevant and understandable patterns from ATM performance data;
- to investigate new data-driven modelling techniques and evaluate their potential to provide new insights about cause-effect relationships between performance drivers and performance indicators;
- to integrate the newly developed analytical and visualisation functionalities into an interactive dashboard supporting multi-dimensional performance assessment and decision making for both monitoring and management purposes.

In 2016 the following first results were obtained:

- The identification of the available data sources on ATM performance, the analysis of their characteristics, and the evaluation of their usefulness for the project was documented.
- The definition of a set of research challenges related to ATM performance, including the need for new metrics and indicators providing new angles of analysis of ATM performance was achieved through deliverable D2.2
- A paper was presented to the 6th SESAR Innovation Days

**ER project 'AURORA'**

In Q2 2016, we kicked off, ramped up and executed the exploratory project AURORA.

AURORA addresses ATM Performance and in particular the need to explore promising new performance indicators for operational efficiency based on aircraft operators' needs. It aims to propose new metrics to assess the operational efficiency of the ATM system with the aim of encapsulating the airspace users' operational objectives, considering fuel consumption, schedule adherence and cost efficiency of the flights.

In 2016 the following first results were obtained:

- Research on the state-of-the-art (i.e. Horizontal Flight Efficiency) and current initiatives to improve efficiency indicators such as 3Di in NATS or STREAM research project;
- Review of SESAR 2020 Performance Framework and in particular, how efficiency indicators are defined in SESAR;
- Input and requirements collected from Airspace User Group
- Definition of new indicators based on previously identified gaps;
- Identification of methods to calculate the new indicators, mainly taking into account several reference trajectories;
- Identification of available information to calculate the indicators and potential information requirements in case of future implementations.

**ER project 'APACHE'**

In Q2 2016, we kicked off, ramped up and executed the exploratory project APACHE.

The APACHE Project proposes a new assessment framework to evaluate the European ATM (air traffic management) performance based on simulation, optimisation and performance assessment tools that will be able to capture complex interdependencies between KPAs (key performance areas) at different modelling scales (micro, meso and macro). In this context, the purpose of APACHE is threefold:

- to evolve the ATM Performance Scheme towards new methodologies and metrics;
- to make an initial impact assessment of long-term ATM concepts with the new APACHE Performance Scheme; and
- to analyse the interdependencies between the different KPAs and the Pareto-frontier of the ATM performance.

In 2016 the following first results were obtained:

- the methodology proposed to achieve and defines the operational context which encompasses the evaluation studies that will be carried out.
- definition APACHE Concept in which by means of high-fidelity simulations and enhanced indicators the ATM performance could be measured accurately (and possibly in real time), enabling in this way the future paradigm of Performance Based Operations.
- definition of functional requirements and specifications for the APACHE framework and design of APACHE System as tool that will be built during the scope of the project
- identification of a group of SESAR solutions as relevant in the framework of the Project. From the complete list of 151 solutions, 23 were identified taking into account the project scope and limitations and considering only SESAR solutions proposed in the SESAR 2020 program..
- KPI review and definition.

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- review of current KPIs were different performance frameworks were thoroughly reviewed.
- proposal of new KPIs with the aim to enhance current indicators or even proposing new ones aiming at better capturing ATM performance. In this context, 52 new (or enhanced) indicators were proposed across 9 KPAs.

### *ATM Excellent Science and Outreach*

### ER project 'AUTOPACE'

In Q1 2016, the 'AUTOPACE' project kicked off, ramped up and initiated execution.

The project performs fundamental research on psychological modelling to predict how future automation would impact on air traffic controller performance and to identify competences and training to cope with the effects of automation on humans. It performs analytical studies to estimate cognitive demanded resources in a 2050 environment based on the multiple resource theory. Later on, Psychologists, ATM Experts, Controllers and Training experts will set the hypothesis to build a Psychological Model of the ATCo cognitive resources based on the attentional theories. Finally, the project will look at the future use of this Psychological Model to support the identification of future competences and training strategies.

During 2016, the project provided a State of the Art report on the research defining the 2050 ATM Concept. Inconsistencies between different sources have been addressed to achieve a consistent concept where the traffic characteristics and operational procedures, the main ATC systems functionalities and the ATM actors and their responsibilities are described. Furthermore, the project delivered the AUTOPACE Concept of Operations (ConOps) and Scenarios based on which automation features and cognitive resources will be assessed. The expected level of automation in 2050 and its effect on procedures, system and personnel has been also identified. AUTOPACE has focused on two levels of automation to address the high uncertainty with regards to the overlapping of responsibilities between the ATC System and the ATCo

- A high degree of automation where the ATC System develops the necessary actions for the orderly and safely traffic management, informing the ATCos.
- A medium degree of automation where the ATC System proposes actions and the ATCo decides which action to apply from the set of proposals displayed.

Upon these two scenarios, non-nominal situations have been identified to support the assessment of automation failures. For each non-nominal situation, the re-allocation of ATC functions that should take place to keep the Air traffic Service provision was identified.

### ER project 'TACO'

In Q3 2016, the TACO project kicked off, ramped up and initiated execution.

TaCo aims to define an automated system sufficiently powerful to both accomplish complex tasks involved in the management of surface movements in a major airport and self-assess its own ability to deal with non-nominal conditions. When needed, such system should be sensitive enough to transfer responsibilities for traffic management back to the controller, in a timely and graceful manner and in way that makes him/her comfortable with the inherited tasks.

The main objectives of TaCo are the following:

- Defining algorithms and solutions to automate and optimize both the decision making and implementation tasks for the controller involved in the ground movement of airport vehicles and aircraft.
- Identifying and providing the controller with suitable and usable tools to supervise (monitor, tune and re-program) the system.
- Studying the interaction between the human actors and the automation. Main focus will be on the identification of sensitive state transaction from a (fully) automated management system to conditions where the human is brought into the loop to handle situations where his/her cognitive resources are essential.

During 2016, the project performed a preliminary analysis of the current operational environment for the Ground Air Traffic Controllers in Malta International Airport (LMML), where the project validation tasks will be held. Four operational scenarios were defined, taking into account the procedures, operational limitations and performance characteristics of the most significant traffic configurations occurring in this airport. The complexity factors specific of this airport have been elicited, analysed and categorised. Identified scenarios and complexity factors will be used as the basis for the definition of suitable automation strategies to support Ground ATCos' work.

**ER project 'AGENT'**

In Q1 2016, the AGENT project kicked off, ramped up and initiated execution.

AGENT aims at contributing to an enhancement of the overall performance of the air transport system, mainly targeting the separation management layer of air traffic and its connections with Trajectory Management and Collision Avoidance. The overall performance of the system shall increase primarily by increasing safety, and improving the efficiency for all agents of the system.

AGENT addresses the following key objectives:

- To propose an innovative automation-based future system design supporting a shift from a nowadays centrally controlled ATM system to a distributed system, in which aircraft and ATC collaborate to form adaptive aerial ecosystems, to find an optimal compromise accounting for safety, capacity and cost-efficiency aspects.
- To develop ATC- and Pilot-side Decision Making Tools to transform aircraft and ATC into Intelligent Agents that can communicate with each other using machine-to-machine interfaces with the aim to safely make best use of existing airspace capacity.
- To build ontology for knowledge representation, reasoning and machine-to-machine communication between intelligent agents.
- To verify the AGENT DMT's using real traffic information and validate results by means of the scenarios in a simulated environment with traceable and transparent information.
- To demonstrate and quantify the potential for the innovative ATM design to provide benefits in safety, capacity and efficiency of ATM operations, ensuring a wider acceptance of the research results and conducting demonstration activities used to build confidence in the effectiveness of the concept.

During 2016, the project started by analysing the User Needs, identifying its Automated ATM system requirements, and by defining its Concept of Operations, delimiting the scope of the project and defining the requirements for the development of AGENT functionalities. The main requirements were defined for each function within the ConOps, and non-functional requirements were defined for alignment with the safety and efficiency targets for the future ATM.

### ER project 'STRESS'

In Q3 2016, the STRESS project kicked off, ramped up and initiated execution.

The roles and tasks of air traffic controllers (ATCOs) will change in the future and it is vital to enhance the comprehension of human responses to their role changing, from active control to monitoring of complex situations and managing unexpected system disruptions. The main goal of the project is to generate knowledge to support the design of the technologies which will be used by future controllers to manage the future air traffic scenarios in a fully automated ATC environment. The project will in particular provide guidelines for the future automated systems that are compatible with human capabilities and limitations, ensuring that the right balance between humans and automations is obtained.

STRESS is aiming in particular to improve the knowledge on:

1. Human Factors, described in terms of specific cognitive processes and mental states.
2. Neurophysiological characterization of stress, attention, cognitive control and workload phenomena.
3. Combination of the indexes to test the possibility to simultaneously measure such mental states along the execution of tasks.
4. Testing of Automation and its impact/relationship to Human Performance

During 2016, the first two topics were addressed by the project. In particular, the mental state of stress, attention, cognitive control and workload have been characterized by means of specific cognitive processes. Neurometrics have then been defined by combining the considered neurophysiological signals with the aim to measure and track such mental state changes along the execution of laboratory tasks. These laboratory tasks were designed by considering common features and reproducible events with ATM scenarios.

### ER project 'MINIMA'

In Q2 2016, the MINIMA project kicked off, ramped up and initiated execution.

The monitoring role of human operators results in negative effects, such as lack of attention, loss of SA (Situation Awareness) and skill degradation. It is expected that a monitoring task reduces controller's ability to detect problems (e.g., conflicting aircrafts), to determine the current state of the system, to understand events, and to react to situations. Therefore, new forms of automation, including Adaptive Automation (AA), should be taken into account to moderate the operator workload while preserving his SA. As a result, a better match between the task demands and the controller cognitive resources will be achieved. In any case, one must avoid keeping the controller 'out-of-the-loop'.

MINIMA will develop an automated system capable of providing substantial and verifiable capacity and efficiency benefits while fully addressing safety concerns by developing adaptive automation to prevent the risks associated with assigning a monitoring role to the human operator, such as dissatisfaction, lack of attention, loss of SA and de-skilling. Based on the developed automation, MINIMA will provide guidance for the future design of fail-safe complex human-machine environments in the presence of high levels of automation.

Until now, a State of the Art Review was completed and the MINIMA Concept was developed.

The State of the Art Report describes first the analysis of the out-of-the-loop phenomenon that can be expected when automation in air traffic control is increased. Second, it further covers existing

solutions in other domains to mitigate the OOL problem. Third, psychophysiological measures are analysed and their suitability to determine air traffic controllers' vigilance and attention are evaluated. The results of this task were presented on the SESAR Innovation Days (as a poster) and will be disseminated on the Human Computer Interaction (HCI) International as presentation and paper.

In 2016, the project delivered the State of the Art Review and the Concept for the Vigilance and Attention Observer in a highly automated TMA. The developed Concept describes the operational environment that will be used in MINIMA, the methods for measuring the vigilance and attention, and describes the technical implementation and the interface between the various components.

**ER project 'BigData4ATM'**

In Q2 2016, the BIGData4ATM project kicked off, ramped up and initiated execution.

ATM operations have so far lacked a passenger-oriented perspective, with performance objectives not necessarily taking into account the ultimate consequences for the passenger. There is a lack of understanding of the impact of passengers' behaviour on ATM and vice versa. Research in this area has so far been constrained by the limited availability of behavioural data. The pervasive penetration of smart devices in our daily lives and the emergence of big data analytics open new opportunities to overcome this situation: for the first time, we have large-scale dynamic data allowing us to test hypotheses about travellers' behaviour.

The goal of BigData4ATM is to investigate how these data can be analysed and combined with more traditional demographic, economic and air transport databases to extract relevant information about passengers' behaviour and use this information to inform ATM decision making processes. The objectives of the project are:

1. to integrate and analyse multiple sources of passenger-centric spatio-temporal data (mobile phone records, data from geolocation apps, credit card records, etc.) with the aim of eliciting passengers' behavioural patterns;
2. to develop new theoretical models translating these behavioural patterns into relevant and actionable indicators for the planning and management of the ATM system;
3. to evaluate the potential applications of the new data sources, data analytics techniques and theoretical models through a number of case studies, including the development of passenger-centric door-to-door delay metrics, the improvement of air traffic forecasting models, the analysis of intra- airport passenger behaviour and its impact on ATM, and the assessment of the socio-economic impact of ATM disruptions.

During 2016, the work has focused on:

- gathering and assessing the different datasets that will be analysed throughout the project,
- conducting a detailed literature review and a consultation process with a variety of ATM stakeholders, in order to define the research questions that will be addressed during the remaining of the project.
- addressing the complex ethical requirements assigned to this project.
- starting to analyse the main data available for socioeconomic and behavioural research in ATM. In the subsequent stages of the project, the collected datasets will be integrated and analysed to extract new knowledge about passengers' behaviour.

**ER project 'DART'**

In Q3 2016, the DART project kicked off, ramped up and initiated execution.

The main research objective of DART project is to explore the application of different data-driven techniques to the aircraft trajectory prediction, also accounting for complexity ATM network effects.

DART will deliver understanding on the suitability of applying data-driven techniques both for predicting single aircraft trajectories without considering traffic, as well as for predicting multiple correlated aircraft trajectories.

To achieve this high-level main research objective, the following specific research objectives have been defined:

- Study of the application of big-data techniques to trajectory related data gathering, filtering, storing, prioritization, indexing or segmentation to support the generation of reliable and homogenous input datasets.
- Study of different data-driven learning techniques to describe how a reliable trajectory prediction model will leverage them.
- Formal description of the complexity network to support correlated multiple trajectory predictions.
- Study of the application of agent-based models to the prediction of multiple correlated trajectory predictions considering complexity network.
- Description of visualization techniques to enhance trajectory data management capabilities.
- Exploration of advanced visualization processes for data-driven model algorithms formulation, tuning and validation, in the context of 4D trajectories.

During 2016, the project delivered in particular:

- A study on state of the art algorithms for trajectory prediction with emphasis on single trajectory prediction
- A study on state of the art algorithms on agent-based modelling in ATM
- A proposal on novel approaches to apply Data-Driven algorithms for trajectory predictions
- A specification of scenarios and requirements for single and multiple trajectory predictions

**ER project 'MALORCA'**

In Q2 2016, the MALORCA project kicked off, ramped up and initiated execution.

The ATM world is interested in deploying Assistance Based Speech Recognition (ABSR) applications to provide more sophisticated assistant systems. ASR is a potential extension of many existing systems where speech is the primary mode of communication, such as Arrival Managers (AMAN), Surface Managers (SMAN), and Departure Managers (DMAN). The goal of MALORCA is to progress the development and validation of Assistance Based Speech Recognition (ABSR) systems for ATC, to facilitate the transition from laboratory to the real world.

MALORCA main objectives are to:

- Develop a multi-modal, state-of-the-art, automatic learning system for ABSR by bringing together experts from data science, machine learning, speech processing and recognition and air traffic control
- Automate the state-of-the-art re-learning and adaptation process of the ABSR models to new environments and conditions through unsupervised and semi-supervised learning.

- Experiment the usage of the prototype in Prague (ANS CR) and Vienna (Austro Control).
- MALORCA has collected speech and radar data from Vienna and Prague approach (approx. 100 hours each). A basic Arrival Manager was developed for Vienna and Prague which enables to predict command hypotheses for each controller command spoken to the pilot. The speech data were transcribed (speech-to-text) and annotated (text-to-relevant concepts, e.g.

During 2016, an Operational Concept Document specifying controllers' preferences to benefit from applying speech recognition in ATM was delivered. The project collected and annotated operational speech and radar data from Vienna and Prague Approach, and developed a basic Arrival Manager enabling to predict command hypotheses for each controller command spoken to the pilot. The Operational Concept Document together with the annotated speech data provided an input for creating the System Requirement Specification. A basic recognition system was implemented for developing and testing the automatic learning algorithms.

**ER project 'BEST'**

In Q3 2016, the BEST project kicked off, ramped up and initiated execution.

The main objective of BEST is to determine how semantic technologies can be used effectively to maximise the benefits of adopting SWIM.

BEST will evaluate the use of semantic technologies in several realistic ATM use cases. Semantic technologies are advanced tools and techniques enabling flexible information management, including information extraction and integration from multiple sources. The aim is to support the new paradigm for ATM information management envisioned by SWIM. The project will use practical experience gained in the project to produce guidelines for practitioners about how these technologies can be used in innovative yet scalable ways in order to support the mission of SWIM.

During 2016, the project focused around establishing an ontological infrastructure composed of ontology modules that will be utilised by the solutions developed in the project. The transformation from AIRM (Aeronautical Information Reference Model) to such ontology modules is accomplished using a set of transformation rules defined within the project. The delivered ontological infrastructure will be publicly available, alongside guidelines and tutorials describing how it can be applied together with semantic technologies in other settings.

**ER project 'TBO-MET'**

In Q3 2016, the TBO-MET project kicked off, ramped up and initiated execution.

The project addresses the problem of analysing and quantifying the effects of meteorological uncertainties in Trajectory Based Operations. In particular, two problems are considered: 1) trajectory planning under meteorological uncertainties and 2) sector demand analysis under meteorological uncertainties, which correspond to two different scales: trajectory (micro) scale and sector (meso) scale. In each problem two types of meteorological uncertainties are considered: wind uncertainty and convective zones (including individual storm cells). Weather predictions will be based on Ensemble Probabilistic Forecasts and Nowcasts.

The specific objectives of the project are:

- To improve the predictability of aircraft trajectories when subject to meteorological uncertainty keeping acceptable levels of efficiency, and

- To increase the accuracy of the prediction of sector demand when meteorological uncertainty is taken into account.

During 2016, the work focused on setting the management framework, defining the inputs for the technical work and conducting the survey among stakeholders.

**ER project 'ATM4E'**

In Q3 2016, the ATM4E project kicked off, ramped up and initiated execution.

Systematic and simultaneous consideration and optimization of environmental impacts, comprising climate impact, air quality and noise issues, are currently lacking. ATM4E addresses this gap and explores the feasibility of a concept for a multi-dimensional environmental assessment of ATM operations working towards environmental optimization of air traffic operations in the European airspace.

The project has the following objectives:

- To establish a multi-dimensional environmental change function (ECF) concept, which includes air quality impact (for key pollutants) and perceived noise in addition to climate impact. This will constitute a new metric for an environmental assessment.
- To plan flight trajectories which mitigate the environmental impact for characteristic meteorological situations based on different ATM constraint assumptions and optimization strategies and investigate to what extent the resulting changes in traffic flows lead to particular challenges for air traffic management when such optimization is performed.
- To evaluate environmentally-optimized routes in a future atmosphere in a comprehensive climate-chemistry modelling allowing a proof of concept of climate-optimisation with daily route analysis.
- To develop, in collaboration with aviation stakeholders, a roadmap including an implementation strategy and recommendations for the environmental optimization of aircraft trajectories.

During 2016, the project made progress towards delivering a multi-dimensional environmental assessment framework. Such a framework unifies individual environmental impacts of aviation and environmental performance criteria. This will enable a comprehensive, simultaneous analysis of environmental performance of aircraft operations and trajectories.

**ER project 'PNOWWA'**

In Q3 2016, the PNOWWA project kicked off, ramped up and initiated execution.

In ATM; the 4D trajectory management is a necessary concept to meet future growth in air traffic. However, aircraft always deviate from the planned 4D trajectory due to uncertainties during flight, departure and arrival airport. Therefore, there is a clear need to move to probability forecasts both in the local operational user environment and en-route.

PNOWWA concentrates in quantifying the uncertainties related to delays at ground operations due to winter weather situations. The overarching objectives of using probabilistic forecasts in ATM applications are to support the timely operations in surface management and ATM decision making, to increase airport capacity, as well as to shorten delays and promote safety. PNOWWA will provide the scientific basis for these ground-braking improvements in the 4D trajectory management.

PNOWWA objectives are to:

- Develop a method for probabilistic 0-3h forecasts (nowcasts) of snowfall and freezing rain at airport, in steps of 15 minutes.
- Improve our understanding, and hence predictability, of changes in snowfall intensity caused by underlying terrain, e.g., mountains and sea.
- Identify and promote the potential for use of probability forecasts in variety of airport activities.
- Make research demonstration of probabilistic winter weather product to show its potential for increasing the resilience of ATM system to winter weather.

During 2016, the project performed a survey for determining the user needs and use of winter precipitation forecast at one selected airport, implemented software to calculate probabilistic nowcasts using three different methods, and planned the research demonstrations to be carried out in the next springtime with different ATM cooperating partners.

**ER project 'COCTA'**

In Q2 2016, the COCTA project kicked off, ramped up and initiated execution.

If ATM capacity exceeds demand, costs for providing ATM services and consequently ATM charges are above the inevitable level. In case of capacity shortages, airlines and other aircraft operators are forced to deviate from their optimum flight plans, leading especially to delays and additional fuel burn. The COCTA project aims at increasing efficiency by better matching ATM capacity and demand. This will be achieved by a structural redesign of the ATM value chain as well as by several innovations within the system. On the demand side, aircraft operators will be incentivized to reveal their preferences at an earlier stage and to also signal their degree of flexibility with respect to flight times and routes. On the supply side, capacity provision by different Air Navigation Service Providers (ANSPs) in neighbouring regions should be better coordinated by the Network Manager (NM), who serves as an intermediate institution between capacity supply and demand within the COCTA framework.

The redesign of the ATM value chain is conceptual research, i.e. the numerous possible options for the changed institutional environment will have to be identified and analysed within the project. The COCTA project thereby links the results of recent research on ATM economics with an innovative modelling approach and a conceptual design which has not been analysed before.

During 2016, the COCTA project team performed an in-depth review of the relevant literature and available data, and developed a first simplified model which shows that a better coordination of capacity supply in neighbouring regions is indeed a suitable measure for reducing the overall costs of ATM service provision. This model is still based on an illustrative academic example rather than actual traffic data. Future results will include models based on real traffic data.

**ER project 'Vista'**

In Q3 2016, the VISTA project kicked off, ramped up and initiated execution.

The effects of conflicting market forces on European performance in ATM are being examined by VISTA through the evaluation of impact metrics on four key stakeholders, and the environment. Vista is also studying the relationships between three major regulatory instruments in Europe: (i) the binding targets set in the context of the Single European Sky Performance Scheme, (ii) the passenger compensation and assistance scheme (Regulation 261) and (iii) the European emissions trading system, plus the goals and targets set out in the EC's high-level vision document for aviation in 2050 (Flightpath 2050). These instruments are currently not systematically coordinated.

The primary objectives of VISTA are to quantify the current and future relationships between a presently non-reconciled set of performance targets and (binding) regulations in operation in Europe, specifically:

- The trade-off between, and impacts of, primary regulatory and business (market) forces.
- The horizontal metric trade-offs within any given period.
- The vertical trade-offs between periods, particularly as many targets are not currently mapped from year to year, are discontinuous with other targets, or even entirely missing for given periods (such as, vitally, passenger performance targets).
- Whether alignment may be expected to improve or deteriorate as we move closer to Flightpath 2050's timeframe.

During 2016, progress has been made in the core technical work:

- Identification of relevant regulations and business factors that affect the processes/metrics;
- Definition of regulatory factors (and instruments) and business factors (and tools/technologies).
- Selection of the foreground and background factors from the regulatory and business factors, with an indication of which phase of the ATM process (strategic, pre-tactical, tactical) is affected;
- Definition of background scenarios from the background factors that are reasonable from the stakeholder perspective and as a whole;
- Identification of model variables that are affected by the background scenarios and foreground factors, and how they are affected.
- High-level model definition and platform description: the identification of key characteristics of the stakeholders to be modelled; the temporal and spatial scope; the metrics and trade-offs to be analysed and the modelling technique selected for Vista.

**ER project 'COMPAIR'**

In Q1 2016, the COMPAIR project kicked off, ramped up and initiated execution.

The main goal of the COMPAIR project is to increase insight into potential institutional and market structures that may lead to an uptake of new technologies and more performance based business models. The main research question of *COMPAIR is "how to introduce competitive incentives in the ATM sector so as to best contribute to the achievement of the European high-level policy objectives for aviation."*

In reply to this research question, the project pursues the following objectives:

- Propose a set of new institutional market designs for the introduction of competition in the European ATM sector.
- Define a framework allowing a comprehensive assessment of the impact of different institutional market designs on ATM stakeholders and society at large.
- Develop a variety of economic and network models for the evaluation of the proposed regulatory approaches.
- Assess the feasibility and acceptability of proposed institutional changes for various market actors.
- Propose a vision and derive policy recommendations for the implementation of those new institutional structures identified as most beneficial for the European ATM system.

During 2016, the project started by assessing the four proposed scenarios for increasing competition:

- Regulatory approach using yardstick competition.
- Auctioning approach using tenders to license air navigation services within a certain charging zone.
- Unbundling of central infrastructure management tasks from service provision tasks.
- Sector-less based operations where trajectories are managed per origin-destination.

These concepts were further assessed by using multiple modelling approaches. In order to ensure the comparability of the modelling work, the project agreed on common modelling guidelines and on an integrated assessment framework.

***ATM application-oriented research for 'High Performing Airport Operations' Key Feature***

**MOTO**

MOTO will perform research on ATM Human Performance of using two senses: sight and hearing in the context of remote tower operations.

The grant related to the MOTO project entered into force in May 2016 and, subsequently, the project started in June. The PMP was submitted to the SJU in July 2016 and is still to be accepted.

**RETINA**

RETINA project will investigate the potential and applicability of SV tools and Virtual/Augmented Reality display techniques for the Air Traffic Control service provision by the airport control tower.

The grant related to the MOTO project entered into force in February 2016 and, subsequently, the project started in March. The PMP was submitted to the SJU in April 2016 and accepted in February 2017.

ATM application-oriented research for 'Advanced air traffic services' Key Feature

**SALSA**

SALSA is an exploratory research project relating to multi-source ADS-B system.

**R-WAKE**

R-WAKE aims at developing a simulation framework to assess the risk and hazards of potential wake vortex encounters for the en-route phase of flight.

**OptiFrame**

The main objective of the OptiFrame research project is the application of principles of mathematical modelling and optimization to optimally configure and assess the performance of the Trajectory Based Operations (TBO) concept. OptiFrame will allow verifying the viability of the TBO concept, to identify the major issues that need to be addressed, and to understand whether, under which conditions, and to what extent the objectives of flexibility of airspace users and predictability of the Air Traffic Management (ATM) system can be achieved.

In Q2 2016, the exploratory project OptiFrame was kicked off, ramped up and executed. 2016 saw the development of the project management plan and some initial research documents:

- Implementation of three major streams of activities, namely: project management, technical, and dissemination activities;
- Description of the TBO concept, identification of barriers and enablers for its implementation, identification of the issues involved in the definition of the preferences and priorities for the implementation of the TBO concept (which were used as an input for the preparation of the stakeholders' workshop), and review of the ATFM literature which is relevant to the modelling of the TBO concept;
- Design of the Data Management Platform (DMP);
- Exploration of the development of alternative preliminary modelling approaches for representing the trajectory based operations optimization problem.

**COPTRA**

COPTRA proposes an efficient method to build probabilistic traffic forecasts on the basis of flight trajectory predictions within a Trajectory Based Operations (TBO) environment. Its main goal is using the improvements brought to trajectory prediction by the future TBO environment to bring measurable improvements to traffic prediction in ATC Planning.

The main concepts defined, modelled and studied by COPTRA are the notions of probabilistic trajectories and traffic situations. The central idea researched is to develop new methods to build the probabilistic traffic prediction by combining the probabilistic trajectories.

In Q2 2016, the exploratory project COPTRA was kicked off, ramped up and executed. 2016 saw the development of the project management plan and some initial research documents:

- Identification of Uncertainty Quantification (UQ) techniques and how they can be applied to the aircraft trajectory prediction problem;
- Definition of the conceptual interfaces between the models for probabilistic trajectories and traffic situations, as well as the definition of the benefit mechanisms that support the application of these models to Dynamic Capacity Balancing (DCB).

**PARTAKE**

PARTAKE will propose a causal model to enhance the potential synergies that could be achieved by exploiting to the maximum extend the gap provided by the strategic decision variables and the operational decision making at flight execution.

The main objectives if the project PARTAKE are:

- Design a cooperative departure for a competitive ATM network service.
- Identification of trajectory interdependencies by means of the spatio-temporal causal analysis tools.
- Preserve AU's trajectory preferences.
- Minimize ATC interventions without affecting ATFCM.

In Q1 2016, the exploratory project PARTAKE was kicked off, ramped up and. In 2016 the following results were obtained:

- Definition of the TBO requirements;

- Definition of the evaluation strategy;
- TBO mapping tools design;
- Definition and Modelling of Requirements of Trajectory Interdependencies.

***ATM application-oriented research for 'Enabling ATM Infrastructure' Key Feature***

**NAVISAS**

NAVISAS project will propose a novel concept of APNT for small aircraft that will integrate novel technologies and will merge multiple navigation avionics into one with no major impact on avionics.

**SAPIENT**

SAPIENT project addresses a new innovative application in the field of CNS/ATM system focusing exploitation of the synergies of Communications and Navigation technologies and the 4D trajectory management concept.

**3. Industrial Research & Validation**

Agreements settlement phase was successfully closed. The kick-off meetings of all 17 Industrial Research & Validation projects took place in the course of the period Q3-Q4 2016 and Q1 2017.

**4. Very Large-Scale Demonstrations**

Agreements settlement phase was successfully closed. The kick-off meetings of all 5 Very Large-Scale Demonstration activities took place in the course of the period Q3-Q4 2016 and Q1 2017.

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## 5. Horizon 2020 Scoreboards

The table below follows the instructions on Annual Activity Reports for Joint Undertakings operating under Horizon 2020:

### 5.1 Scoreboard of Horizon 2020 common KPIs

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[27] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 1 | SME - Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years);(Number of SMEs that have introduced innovations) | Number and % of participating SMEs that have introduced innovations to the company or to the market | N | n/a | 2 |
| 2 | SME - Growth and job creation in participating SMEs (turnover of company, number of employees) | Turnover of company  Number of employees | N | n/a | Turnover EUR 22.509.957 Number of employees not available |
| 3 | Number of publications in peer-reviewed high impact journals | The percentage of papers published in the top 10% impact ranked journals by subject category. | N | n/a | 16 |
| 4 | Patent applications and patents awarded in the area of the JTI (number of patents awarded) | Number of patent applications by theme Number of awarded patents by theme | N | n/a | |

[27] Data not provided by SJU is provided by beneficiaries through project reporting

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| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[27] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 5 | Number of prototypes testing activities and clinical trials | Number of prototypes, testing (feasibility/demo) activities, clinical trials | N | n/a | Prototypes: 1<br>Testing activities: 6<br>Clinical trials: n/a |
| 6 | Number of joint public-private publications in projects | Number and share of joint public-private publications out of all relevant publications. | N | n/a | 7 |
| 7 | New products, processes, and methods launched into the market | Number of projects with new innovative products, processes, and methods | N | n/a | Innovative products: 2<br>Innovative processes: 3<br>Innovative methods: 3 |
| 8 | Time to inform (TTI) all applicants of outcome of evaluation | Number and % of information letters sent to applicants within target (153 days)<br>Average TTI (calendar days)<br>Maximum TTI (calendar days) | Y | 123 (100%)<br>Average 146 days (Maximum 147 days)[28] | 27 (100%)<br>Average 79 days<br>Maximum: 79 days[29] |
| 9 | Redress after evaluation/evaluation review | Number of redressed requested | Y | 0% | 0% |
| 10 | Time to grant (TTG) from call deadline to grant signature | Number and % of grants signed within target (243 days) | Y | n/a | 32 out of 53 (60,4%) |

[28] Refers to call H2020-SESAR-2015-1

[29] Refers to call H2020-SESAR-2015-2

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| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[27] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| | | Average TTG in calendar days | | | Average: 240 days |
| | | Maximum TTG in calendar days | | | Maximum: 358 days[30] |
| 11 | Time to sign (TTS) from successful applicant letter | Number and % of grants signed within target (92 days) | Y | n/a | 6 out of 53 (11,3%) |
| | | Average TTS in calendar days | | | Average 126 days |
| | | Maximum TTS in calendar days | | | Maximum: 214[31] |
| 12 | Time to pay (% on time) for pre-financing, interim payment & final payment | Average number of days for Grants pre-financing (target 30 days), interim payments (target 90 days)and final payments (target 90 days) | Y | n/a | Grants pre-financing < 30 days |
| | | Average number of days for administrative payments | | | |
| | | Number of experts appointed | | | |
| 13 | Vacancy rate (%) | % vacancy rate during the reporting period | Y | 2% | 0% |

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[30] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[31] Refers to call H2020-SESAR-2015-2

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[27] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 14 | Budget implementation/execution:<br>1. % CA to total budget<br>2. % PA to total budget | % of CA and PA | Y | 100% | 100% |
| 15 | Administrative Budget: Number and % of total of late payments | Number of delayed payments | Y | | 0% |

**Table 22: Scoreboard of Horizon 2020 common KPIs**

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### 5.2 Indicators for monitoring cross-cutting issues

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 16 | Number of nationalities in H2020 applicants & beneficiaries | Nationality of Horizon 2020 applicants & beneficiaries (number of ) | N | n/a | 22[33] |
| 17 | Total amount of EU financial contribution by member state | Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution | N | n/a | Austria: EUR 7.675.171 Belgium: EUR 7.840.517 Croatia: EUR 1.050.692 Czech Republic: EUR 2.827.580 Denmark: EUR 1.837.491 Finland: EUR 290.125 France: EUR 100.861.626 Germany: EUR 20.279.307 Greece: EUR 170.000 Hungary: EUR 700.079 Ireland: EUR1.980.327 Italy: EUR 33.961.124 Lithuania: EUR |

[32] Data not provided by SJU is provided by applicants or beneficiaries at the submission or at grant agreement stage

[33] Refers to calls H2020-SESAR-2015-1 (applicants and beneficiaries) and H2020-SESAR-2015-2 (applicants)

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| | | | | | 1.297.799 Luxembourg: EUR 72.000 Malta: EUR 118.750 Netherlands: EUR 2.748.284 Poland: EUR 2.467.230 Portugal: EUR 478.675 Slovakia: EUR 1.837.362 Spain: EUR 45.210.363 Sweden: EUR 8.376.403 United Kingdom: EUR 14.113.197[34] |
| 18 | Number of nationalities in H2020 applicants & beneficiaries (associated countries) | Nationality of Horizon 2020 applicants & beneficiaries (number of ) | N | n/a | 6 (Iceland, Israel, Norway, Serbia, Switzerland, Turkey)[35] |

[34] Refers to calls H2020-SESAR-2015-1 (applicants and beneficiaries) and H2020-SESAR-2015-2 (applicants)

[35] Refers to call H2020-SESAR-2015-1 and H2020-SESAR-2015-2

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| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|-----|------------------------------------------|------------|--------------------------|---------------|---------------|
| 19 | Total amount of EU financial contribution by associated country | Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution | N | n/a | Iceland: EUR 26.700 Israel: EUR 171.125 Norway: EUR 4.675.415 Serbia: EUR 445.566 Switzerland: EUR 5.195.615 Turkey: EUR 373.125 TOTAL: EUR 10.887.547 |
| 20 | Share of EU financial contribution going to SMEs | Number of Horizon 2020 beneficiaries flagged as SME; % of EU contribution going to beneficiaries flagged as SME | N | n/a | 11,3%[36] |
| 21 | Percentage of women in H2020 projects | Gender of participants in Horizon 2020 projects | N | n/a | 10%[37] |
| 22 | Percentage of women project coordinators in Horizon 2020 | Gender of MSC fellows, ERC principle investigators and scientific coordinators in other Horizon 2020 activities | N | n/a | 13,75%[38] |

[36] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[37] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[38] Refers to call H2020-SESAR-2015-2

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 23 | Percentage of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc. | Gender of memberships in advisory groups, panels, etc. | Y | 13,8% women | 25%[39] |
| 24 | Share of third-country participants in Horizon 2020 | Nationality of Horizon 2020 beneficiaries | N | n/a | 0 |
| 25 | Percentage of EU financial contribution attributed to third country participants | Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution | N | n/a | 0 |
| 26 | Share of projects and EU financial contribution allocated to Innovation Actions (IAs) | Number of IA proposals and projects properly flagged in the WP; follow up at grant level. | Y | n/a | Number of IA projects: 5<br><br>% of IA projects out of all proejcts: 9%<br><br>% of EU contribution for IA out of overall EU contribution: 11%[40] |
| 27 | Within the innovation actions, share of EU financial contribution focussed on demonstration and first-of-a-kind activities | Topics properly flagged in the WP; follow-up at grant level | Y | n/a | 100% (all IA projects are VLD activities) [41] |

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[39] Refers to call H2020-SESAR-2015-2

[40] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[41] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

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| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 28 | Scale of impact of projects (high-technology readiness level) | Number of projects addressing TRL between ...(4-6, 5-7)? | Y | n/a | 28 projects up to TRL 2 20 projects from 2 to 6 5 projects from 6 to 7 |
| 29 | Percentage of H2020 beneficiaries from the private for profit sector | Number of and % of the total Horizon 2020 beneficiaries classified by type of activity and legal status | Y | n/a | 357 out of 707 (50,5%)[42] ER: 38 out of 128 (29%)[43] IR-VLD: 319 out of 579 (55%)[44] |
| 30 | Share of EU financial contribution going to private for profit entities (Enabling & industrial tech and Part III of Horizon 2020) | Horizon 2020 beneficiaries classified by type of activity; corresponding EU contribution | Y | n/a | |
| 31 | EU financial contribution for PPP (Art 187) | EU contribution to PPP (Art 187) | Y | n/a | |

[42] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[43] Refers to call H2020-SESAR-2015-1

[44] Refers to call H2020-SESAR-2015-2

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 32 | PPPs leverage: total amount of funds leveraged through Art. 187 initiatives, including additional activities, divided by the EU contribution | Total funding made by private actors involved in PPPs<br><br>- in-kind contribution already committed by private members in project selected for funding<br><br>- additional activities (i.e. research expenditures/investment of industry in the sector, compared to previous year) | Y | n/a | |
| 33 | Dissemination and outreach activities other than peer-reviewed publications. | A drop down list allows the choice of the type of dissemination activity. Number of events, funding amount and number of persons reached thanks to the dissemination activities | N | n/a | |
| 34 | Proposal evaluators by country | Nationality of proposal evaluators | Y | Israel: 1;<br>Danish: 2;<br>English:7;<br>Sweden; 1;<br>Italian: 3;<br>French: 6;<br>Dutch:5;<br>Spanish:1;<br>Bugarian:1;<br>Greek:1 | Serbian: 1<br>French: 5<br>UK: 2<br>+ SJU staff involved in the evaluation<br>Belgian: 2<br>UK:4<br>French: 4<br>Dutch: 3<br>Spanish: 3<br>Italian: 1<br>Turkish:1 |

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| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 35 | Proposal evaluators by organisations' type of activity | Type of activity of evaluators' organisations | Y | Industry: 3<br>University: 1<br>Airspace users: 1<br>ATM Research: 8<br>(+5 SJU) | Industry: 1<br>University: 7<br>(+ 20 SJU) |
| 36 | Participation of RTOs and Universities in PPPs | Number of participations of RTOs to funded projects and % of the total<br>Number of participations of Universities to funded projects and % of the total<br>% of budget allocated to RTOs and to Universities | Y | n/a | 159 out of 707 (22,5%)[45]<br>ER: 75 out of 128 (58,6%)[46]<br>IR-VLD: 84 out of 579 (14,5%)[47] |
| 37 | The objective is ensuring that research projects funded are compliant with provisions on ethics efficiently | % of proposals not granted because non-compliance with ethical rules/proposals invited to grant (target 0%); time to ethics clearance (target 45 days) | Y | 0% | 0% |

[45] Refers to calls H2020-SESAR-2015-1 and H2020-SESAR-2015-2

[46] Refers to call H2020-SESAR-2015-1

[47] Refers to call H2020-SESAR-2015-2

| REF | Name of H2020 Key Performance Indicator | Definition | Data provided by SJU[32] | Value in 2015 | Value in 2016 |
|---|---|---|---|---|---|
| 38 | Error rate | % of common representative error<br>% residual error | Y | n/a | 7,29%<br>6,21% |
| 39 | Implementation of ex-post audit results for H2020 projects | Number of cases implemented<br>in total €million<br>of cases implemented/total cases | Y | n/a | n/a |

**Table 23: Indicators for monitoring cross-cutting issues**

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## Annex I.3    Procurement activity in 2016

The SJU was able to complete the following procurement procedures in 2016.

| Type of procurement | Subject / Title of the contract | Amount | Date launched |
|---|---|---|---|
| Open call for tender | Provision of SESAR development support services (SDSS) to the SESAR Joint Undertaking for SESAR 2020 programme management | EUR 15.000.000 | 01/07/2016 |
| Open call for tender | Airspace Users | EUR 6.000.000 | 28/07/2016 |
| Negotiated procedure - Article 134(1)(b) FR | Provision of Airports expertise for the execution of SESAR 2020 | EUR 1.200.000 | 08/01/2016 |
| Open call for tender | Travel Agency | EUR 100.000 | 26/07/2016 |
| Call for Expression of Interest | Scientific Committee | n/a | 23/06/2016 |

**Table 24: Main procurement activities carried out in 2016**

## Annex 1.4    Scoreboard of KPIs specific to SJU

The tables below provide an overview of KPIs specific to the SJU:

| REF | Name of H2020 Key Performance Indicator | Definition | Value in 2015 | Value in 2016 | Target by 2024 |
|---|---|---|---|---|---|
| 40 | PPP – Leverage: In –kind contributions committed by private members in SESAR 2020 projects selected for funding | Private funding balancing public funding in all project types | n/a | Total whole Programme: 2,03<br><br>IR-VLD<br>Whole programme: 2,14<br>Without Eurocontrol (MA part): 1,43<br><br>ER whole programme 1,10 | 1/3 EU funding, 2/3 non EU funding |
| 41 | Completion of SESAR 2020 programme | Actual v Planned % complete per project as of the end of the reporting period | n/a | n/a | 100% |
| 42 | Delivery of SESAR 2020 Solutions | Number of solutions ready for pre-industrialisation  v plan | n/a | n/a | 70%[48] |

**Table 25: KPIs specific to the SJU – 2016 and comparison with 2015**

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[48] Approximate target. The estimated number of solutions will be refined by the end of 2016 as it will be determined by proposals to the call IR-VLD Wave 1 currently open.

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The table below provides an overview of the KPIs set in the ATM Master Plan, expressing the overall performance expected to be delivered by SESAR 1 and the SESAR baseline (i.e. technology improvements coming from pre-SESAR initiatives), provided that deployment would be achieved in an optimal and timely manner. As SESAR 2020 just started its execution phase for the IR projects, no performance achievement can be reported for these projects. Therefore, indicators provided in the table below refer to achievements of the SESAR 1 programme only:

| REF | Key Performance Area in SESAR 2020 | Key Performance Indicator in SESAR 2020 | 2016 Performance vs 2005 Baseline | 2016 Validation Targets | 2016 performance vs. target |
|---|---|---|---|---|---|
| 43 | Cost efficiency: ANS productivity | Gate-to-gate direct ANS cost per flight[49] | -5,30% | -4,19% | 🟩 |
| 44 | Operational efficiency | Fuel Burn per flight | -2,40% | -2,80% | 🟧 |
| | | Flight time per flight[50] | | No target | |
| | | Departure delay[51] | | No target | |
| 45 | Capacity | Additional flights at congested airports | +11% | 10,40% | 🟩 |
| | | Network throughput additional flights[52] | +38% | +34% | 🟩 |
| 46 | Environment | CO2 emissions | -2,40% | -2,80% | 🟧 |
| 47 | Safety | Accidents with ATM contribution | | -40% | |

**Table 26: KPIs related to ATM Master Plan performance – 2016 and comparison with 2015**

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[49] 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

[50] Derived from fuel burn reduction by deducting the contribution of OFA02.01.01 (0,78%), purely due to vertical profile optimisation.

[51] 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.

[52] Increase in aircraft per volume in current "at-limit" airspace en-route

## Annex II. Statistics on financial management

Statistics on financial management are provided in part II section 2.3.

## Annex III. Organisation chart

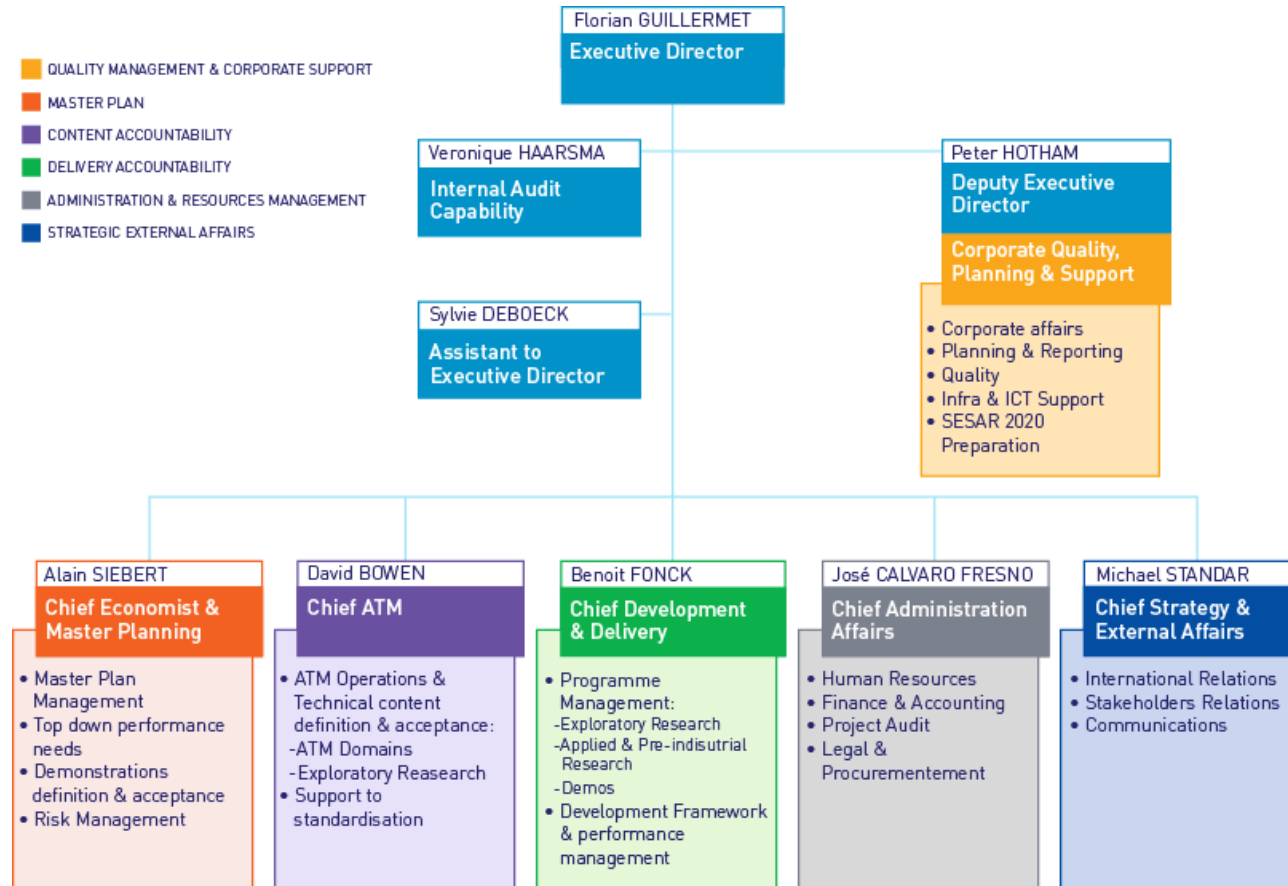At 31$^{st}$ December 2016, the organisation chart was as follows:



**Figure 13: Organisation chart of the SESAR JU as at 31/12/2016**

## Annex IV. Establishment plan

| Activity/Sector | Function / Job title | Contract Type/duration | Grade | # Staff | Administrative support and Coordination / Operational / Neutral |
|---|---|---|---|---|---|
| Executive Director | Executive Director | TA fixed term + renewable | AD 14 | 1 | Operational |
| Vacant | TBD | TA fixed term + renewable | AD 12 | 1 | Operational |
| Audit | Internal Audit Capability | TA fixed term + renewable | AD 5 | 1 | Administrative support and Coordination |
| Executive secretariat | Assistant to the Executive Director | TA indefinite (*) | AST 1 | 1 | Operational |
| Corporate Affairs including corporate support and corporate quality, planning and reporting | Deputy Executive Director Corporate Affairs | TA indefinite (*) | AD 12 | 1 | Administrative support and Coordination / Operational |
| | Head of corporate support | TA indefinite (*) | AD 7 | 1 | Administrative support and Coordination / Neutral |
| | Administrative assistant | TA indefinite (*) | AST 3 | 1 | Administrative support and Coordination |
| | Administrative assistant | TA fixed term + renewable | AST 1 | 1 | Administrative support and Coordination |
| | Head of Corporate quality, planning & reporting | TA fixed term + renewable | AD 8 | 1 | Neutral / Administrative support and Coordination |
| | Corporate planning & reporting officer | TA fixed term + renewable (**) | AST 3 | 1 | Administrative support and Coordination |
| Strategies and relations with ICAO, follow up of MoC with third countries and communication | Chief Strategies & external Relations | TA indefinite (*) | AD 12 | 1 | Operational |
| | Head of International Affairs | TA indefinite | AD 10 | 1 | Operational |
| Relations with different stakeholders and coordination of ED activities | Head of stakeholders and institutional relations | TA fixed term + renewable | AD 10 | 1 | Operational |
| Communication internal/external, media | Senior Communications & Media relations Officer | TA fixed term + renewable | AD 5 | 1 | Operational / Administrative support and Coordination |
| Implementation of the day-to-day communication strategy | Communications & Events officer | TA fixed term + renewable | AD 5 | 1 | Operational / Administrative support and Coordination |

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| Activity/Sector | Function / Job title | Contract Type/duration | Grade | # Staff | Administrative support and Coordination / Operational / Neutral |
|---|---|---|---|---|---|
| Development & delivery, Release and validation | Head of Release Management & Validation Team | TA fixed term + renewable | AD 7 | 1 | Operational |
| | Release outcome manager & Environment officer | TA fixed term + renewable | AD 7 | 1 | Operational |
| Development & delivery, development framework | Call Coordinator | TA fixed term + renewable | AD 9 | 1 | Operational |
| | Grant Manager | TA fixed term + renewable | AD 6 | 1 | Operational |
| | Grant Manager | TA fixed term + renewable | AD 6 | 1 | Operational |
| | ATM Architecture Framework Expert | TA fixed term + renewable | AD 5 | 1 | Operational |
| | ATM Performance expert | TA fixed term + renewable | AD 5 | 1 | Operational |
| ATM | Chief ATM | TA fixed term + renewable | AD 10 | 1 | Operational |
| | ATM Expert – Architecture & Systems Engineering | TA fixed term + renewable | AD 8 | 1 | Operational |
| | ATM Expert - Airport & airspace user operations | TA fixed term + renewable | AD 6 | 1 | Operational |
| | ATM Expert - TMA, En-route & network operations | TA fixed term + renewable | AD 6 | 1 | Operational |
| | ATM Expert - CNS & Avionics | TA fixed term + renewable | AD 5 | 1 | Operational |
| | ATM Expert - ATC & Airport Systems | Secondment from Member / 2 years (**) | NA | 1 | Operational |
| AU relations, business case, Master Planning | Chief Economist & Master planning | TA indefinite (*) | AD 10 | 1 | Operational |
| General administration, Finance, legal and HR | Chief Administration Affairs | TA fixed term + renewable | AD 12 | 1 | Administrative support and Coordination |
| Project Audit | Project Auditor | TA fixed term + renewable | AD 5 | 1 | Operational |

| Activity/Sector | Function / Job title | Contract Type/duration | Grade | # Staff | Administrative support and Coordination / Operational / Neutral |
|---|---|---|---|---|---|
| Coordination of the Finance and Budget and Sector and responsibility for the follow up of the SJU Budget | Head of Finance & Budget | TA fixed term + renewable | AD 8 | 1 | Neutral |
| Accounting | Deputy Accounting Officer | TA fixed term + renewable | AST 5 | 1 | Neutral |
| Financial administration | Financial Officer | TA indefinite | AD 6 | 1 | Neutral / Operational |
| Legal Affairs and Contract | Head of the Legal Affairs & Contract | TA indefinite (*) | AD 8 | 1 | Administrative support and Coordination / Operational |
|  | Legal & Procurement Officer | TA fixed term + renewable | AD 5 | 1 | Administrative support and Coordination / Operational |
| Procurement procedures, personal data protection, day-to-day legal issues | Legal & Procurement Officer | TA fixed term + renewable | AD 5 | 1 | Administrative support and Coordination / Operational |
| HR Legal matters | HR Legal Officer and Data Protection Officer | TA fixed term + renewable | AD 5 | 1 | Administrative support and Coordination |
| Recruitment, HR Administration, staff development | HR Officer | TA indefinite (*) | AST 7 | 1 | Administrative support and Coordination |

**Table 27: The 39 positions of the Staff establishment plan per area and activity on 31/12/2016**

*(\*) Staff member eligible to Transitional Provisions Article 2 of Council Regulation (EC) 1361/2008 (10 staff)*
*(\*\*) Position currently filled by a secondment from SJU Member*

The 2 additional temporary positions approved for 2016 and 2017 are the following:

| Activity/Sector | Function / Job title | Contract Type/duration | Grade | Administrative support and Coordination / Operational / Neutral |
|---|---|---|---|---|
| Financial administration | Financial Officer | CA fixed term (2 years) | FGIV | Administrative support and Coordination / Operational |
| Legal Affairs and Contract | Legal Officer | CA fixed term (2 years) | FGIV | Administrative support and Coordination |

**Table 28: The 2 additional positions requested for 2016 and 2017**

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## Annex V. Human and financial resources by activity

Human and financial resources allocation by activity are provided in part II section 2.3.4 and 2.4.

# Annex VI. Specific annexes related to part II

## VI.1    Exception Register

Under Article 32(3) of the EU's Financial Regulation and Article 29 of the SJU's Financial Regulation, the Joint Undertaking is required to implement its budget in compliance with effective and efficient internal control. In practice this means that there must be procedures for monitoring of performance and for follow-up of internal control weaknesses and exceptions.

The SJU has had a procedure in place for the registration and management of exceptions since 2009.

No exception was registered by the SJU in 2016 in the Exception Register.

## VI.2    Follow-up of recommendations and action plans from previous years' audits

The following tables indicate the state of play of the actions taken on IAS and IAC recommendations from previous years:

**IAS audit on operational governance and Master Plan update (2015)**

| n° | Recommendation | Priority | Status |
|---|---|---|---|
| 1 | Reinforce the Master Plan update and reporting | Very Important | |
| 2 | Improve coordination with the Deployment Manager with regard to Level 3 monitoring and reporting | Very important | Expected to be implemented in 2017<br>No significant delays observed |
| 3 | Appointment of the new SJU's working groups | Important | |

**IAS audit on Risk Management (2014)**

| n° | Recommendation | Priority | Status |
|---|---|---|---|
| 1 | Efficiency of the bottom-up approach | Very Important | In agreement with the IAS, deadlines were extended in order to align implementation to H2020 processes. |
| 2 | Supervision / monitoring of the risk management process (bottom-up approach) | Very important | |
| 3 | Linking risks to objectives at SJU level | Important | Implementation is expected in 2017 |

**IAS Limited review report on Grant Management closing of projects (2013)**

| n° | Recommendation | Priority | Status |
|---|---|---|---|
| 1 | Harmonise the documentation of the closing process | Very important | Closed |
| 2 | Review the assessment process of the Final Project Report (FPR) | Very Important | Closed |
| 3 | Improve the content of the Final Project Report | Important | Closed |

| n° | Recommendation | Priority | status |
|---|---|---|---|
| | (FPR) | | |
| 4 | Reinforce document management in the closure process | Very Important | Closed |
| 5 | Clarify the definition and criteria for ranking of the deliverables | Important | Closed |
| 6 | Set up monitoring system for the closing process | Important | Closed |

### IAS – Audit on programme and project management (2012)

| n° | Recommendation | Priority | status |
|---|---|---|---|
| 1 | Strengthen Identification of the Inter-Projects dependencies | Very important | Closed |
| 2 | Strengthen the Synchronisation Status of the projects | Important | Closed |
| 3 | Streamline Change Management | Important | Closed |
| 4 | Enhance coherence in Gate reports assessments | Important | Closed |
| 5 | Enhance follow up actions for the Gate reports assessment | Important | Closed |
| 6 | Reinforce the SJU Members' Declaration in the annual co-financing requests | Important | Closed |
| 7 | Coherence & Validation of quarterly Dash Boards indicators | Desirable | Closed |

### IAC Audit Report Human Resources (2014)

| n° | Recommendation | Priority | status |
|---|---|---|---|
| 1 | Consider promotion of vacancy notices of specialised technical posts in additional channels. | Desirable | |
| 2 | Provide additional information about the SJU recruitment on the   website. | Desirable | |
| 3 | Ensure that the proposal decision of the selection committee is well explained. | Desirable | Open – a follow up audit by the SJU IAC is planned in 2017 |
| 4 | Ensure that personal documents of candidates are collected in the sealed envelope. | Important | |
| 5 | Use historical records of reasons underlying the post leave by the resigning employees. | Desirable | |
| 6 | Enhance consistency in the induction of newcomers. | Desirable | |
| 7 | Ensure that the 'key accountabilities' in the vacancy notice are revised prior to publication. | Important | |

| | | | |
|---|---|---|---|
| 8 | Ensure that of all personal recruitment documents are filed. | Desirable | |
| 9 | Make certain that of all paper and electronic selection process documents are structured and filed. | Desirable | |
| 10 | Make certain that all paper selection process documents are stored securely. | Important | |

## IAC Audit Report on Procurement / Contract management (2013)

| n° | Recommendation | Priority | status |
|---|---|---|---|
| 1 | Enhance current guidance on roles, responsibilities and authority limits | Important | Closed |
| 2 | Involve Contract Managers in the procurement process | Desirable | Closed |
| 3 | Enhance internal planning of procurement process | Desirable | Closed |
| 4 | Ensure easy access and traceability of all documents related to a contract | Important | Significant delay observed / action expected to close in 2017 |
| 5 | Adopt the 'deliverable identification and storage procedure' | Important | Closed |

## IAC audit on Internal Control Standards (2012)

| n° | Recommendation | Priority | status |
|---|---|---|---|
| 1 | Improve ethics guidelines for staff members | Important | Closed |
| 2 | Set up a mechanism to ensure that the ED is systematically provided with reported information related to ethics | Important | Closed |
| 3 | Set up a register of applicable processes and procedures | Desirable | Closed |
| 4 | Assess the applicability of the current Implementing Rules to the new Financial Regulation | Important | Closed |
| 5 | Set up deputising arrangements for the Accounting Officer | Very Important | Closed |
| 6 | Adopt the Business Continuity Plan | Important | Closed |
| 7 | Enhance awareness on safety procedures | Important | Closed |
| 8 | Monitor implementation by the landlord of reported safety issues related to the building | Desirable | Closed |

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| 9 | Complement the Document Management Policy with operational implementation guidelines and an implementing tool | Important | Significant delay observed / action expected to close in 2017 |

**Table 29: 2016 status of the recommendations made by auditors prior to 2016 and the related action plans**

## Annex VII. Specific annexes related to part III

## Internal Control Assessment report at 31/12/2016

| Building blocks | # | Title | Description | Y - 1 SJU's compliance with the ICS | Comments / Actions plan |
|---|---|---|---|---|---|
| **Mission and Values** | ICS 1 | **Mission** | The Agency's raison d'être is clearly defined in up-to-date and concise mission statements developed from the perspective of the Agency's customers. | 2 | The SJU has up-to-date mission statements and management aims to update the internal organisation note to increase the understanding of the organisational values (target date: May 2017). |
| | ICS 2 | **Ethical and Organisational Values** | Management and staff are aware of and share appropriate ethical and organisational values and uphold these through their own behaviour and decision-making. | 3 | |
| **Human Resources** | ICS 3 | **Staff Allocation and Mobility** | The allocation and recruitment of staff is based on the Agency's objectives and priorities. Management promote and plan staff mobility so as to strike the right balance between continuity and renewal. | 3 | The staff average seniority in the SJU is difficult to compare with other institutions average seniority due to roles of very specific nature linked to a the specialized domain of ATM. |
| | ICS 4 | **Staff Evaluation and Development** | Staff performance is evaluated against individual annual objectives, which fit with the Agency's overall objectives. Adequate measures are taken to develop the skills necessary to achieve the objectives. | 3 | |
| **Planning and Risk Management Processes** | ICS 5 | **Objectives and Performance Indicators** | The Agency's objectives are clearly defined and updated when necessary. These are formulated in a way that makes it possible to monitor their achievement. Key performance indicators are established to help management evaluate and report on progress made in relation to their objectives. | 3 | |
| | ICS 6 | **Risk Management Process** | A risk management process that is in line with applicable provisions and guidelines is integrated into the annual activity planning. | 3 | |

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| Building blocks | # | Title | Description | Y - 1 SJU's compliance with the ICS | Comments / Actions plan |
|---|---|---|---|---|---|
| Operations and Control Activities | ICS 7 | Operational Structure: | The Agency's operational structure supports effective decision-making by suitable delegation of powers. Risks associated with the Agency's sensitive functions are managed through mitigating controls and ultimately staff mobility. Adequate IT governance structures are in place. | 2 | The SJU does not have a IT masterplan: the IS Development is outsources and the SJU makes use of EC/H2020 IT tools as far as available. An IDMS is planned to be put in place in 2017. |
| | ICS 8 | Processes and Procedures | The Agency's processes and procedures used for the implementation and control of its activities are effective and efficient, adequately documented and compliant with applicable provisions. They include arrangements to ensure segregation of duties and to track and give prior approval to control overrides or deviations from policies and procedures. | 3 | |
| | ICS 9 | Management Supervision | Management supervision is performed to ensure that the implementation of activities is running efficiently and effectively while complying with applicable provisions. | 2 | The supervision of operational performance is based on the SPD objectives. The reference to useful performance indicators has been identified as an area of improvement to be dealt by with in 2017. |
| | ICS 10 | Business Continuity | Adequate measures are in place to ensure continuity of service in case of "business-as-usual" interruption. Business Continuity Plans are in place to ensure that the Commission is able to continue operating to the extent possible whatever the nature of a major disruption. | 2 | Due to the size of the organisation, its objectives, its priorities, the SJU staff currently does not attend training related to BCP and the BCP is not reviewed yearly. |
| | ICS 11 | Document Management | Appropriate processes and procedures are in place to ensure that the Agency's document management is secure, efficient (in particular as regards retrieving appropriate information) and complies with applicable legislation. | 2 | A Document Management System currently exists but a more capable DMS is being developed with the target to be delivered in 2017. Although a filing system, as described in the ICS Requirement R23 is not in place in the SJU, documents containing confidential and personal information are only available to relevant staff and data protection policy is in place. |
| Information and Financial Reporting | ICS 12 | Information and Communication | Internal communication enables management and staff to fulfil their responsibilities effectively and efficiently, including in the domain of internal control. Where appropriate, the Agency has an external communication strategy to ensure that its external communication is effective, coherent and in line with the Commission's key political messages. IT systems used and/or managed by the Agency (where the Agency is the system owner) are adequately protected against threats to their confidentiality and integrity. | 2 | The SJU has a data management system, but is working on further improving it with the IDMS project. |
| | ICS 13 | Accounting and Financial Reporting | Adequate procedures and controls are in place to ensure that accounting data and related information used for preparing the organisation's annual accounts and financial reports are accurate, complete and timely. | 3 | |
| Evaluation and Audit | ICS 14 | Evaluation of Activities | Evaluations of expenditure programmes, legislation and other nonspending activities are performed to assess the results, impacts and needs that these activities aim to achieve and satisfy. | 3 | |
| | ICS 15 | Assessment of Internal Control Systems | Management assess the effectiveness of the Agency's key internal control systems, including the processes carried out by implementing bodies, at least once a year. | 3 | The SJU does not have a ICC but the position lies with the QPR team. |
| | ICS 16 | Internal Audit Capability | The Agency has an Internal Audit Capability (IAC), which provides independent, objective assurance and consulting services designed to add value and improve the operations of the Agency. | 3 | |

# Annex VIII. Final Financial Accounts

The Financial Annual Accounts for 2016 are provided in a separate document and subject to adoption in a separate procedure.

Pending on this adoption, the main information in relation with the Financial Annual Accounts for 2016 is the following:

**Balance sheet:**

| | Note | 31.12.2016 | 31.12.2015 |
|---|---|---|---|
| | | | *EUR '000* |
| **NON-CURRENT ASSETS** | | | |
| *Intangible assets* | *2.1* | *36* | *131* |
| *Property, plant and equipment* | *2.2* | *63* | *208* |
| *Pre-financing* | *2.3* | *40 840* | *–* |
| | | **40 939** | **338** |
| **CURRENT ASSETS** | | | |
| *Pre-financing* | *2.3* | *35 971* | *61 884* |
| *Exchange receivables and non-exchange recoverables* | *2.4* | *54 250* | *423* |
| *Cash and cash equivalents* | *2.5* | *17* | *10 129* |
| | | **90 237** | **72 436** |
| **TOTAL ASSETS** | | **131 176** | **72 774** |
| | | | |
| **CURRENT LIABILITIES** | | | |
| *Payables and other liabilities* | *2.6* | *(224 339)* | *(314 503)* |
| *Accrued charges and deferred income* | *2.7* | *(18 375)* | *(11 583)* |
| | | **(242 714)** | **(326 085)** |
| **TOTAL LIABILITIES** | | **(242 714)** | **(326 085)** |
| | | | |
| **NET ASSETS** | | **(111 538)** | **(253 311)** |
| | | | |
| *Contribution from Members* | *2.8* | *1 563 940* | *1 264 744* |
| *Accumulated deficit* | | *(1 518 085)* | *(1 233 329)* |
| *Economic result of the year* | | *(157 393)* | *(284 756)* |
| **NET ASSETS** | | **(111 538)** | **(253 311)** |

**Statement** of **financial performance:**

| | Note | 2016 | 2015 |
|---|---|---|---|
| | | | *EUR '000* |
| **REVENUE** | | | |
| **Revenue from non-exchange transactions** | | | |
| *Recovery of expenses* | *3.1* | *299* | *1* |
| | | **299** | **1** |
| **Revenue from exchange transactions** | *3.2* | | |
| *Financial income* | | *1* | *24* |
| *Other exchange revenue* | | *56* | *8* |
| | | **57** | **32** |
| **Total revenue** | | **356** | **33** |
| **EXPENSES** | | | |
| *Operating costs* | *3.3* | *(148 559)* | *(277 093)* |
| *Staff costs* | *3.4* | *(4 576)* | *(4 105)* |
| *Finance costs* | | *(5)* | *(4)* |
| *Other expenses* | *3.5* | *(4 609)* | *(3 587)* |
| **Total expenses** | | **(157 749)** | **(284 789)** |
| **ECONOMIC RESULT OF THE YEAR** | | **(157 393)** | **(284 756)** |

## Cash flow statement:

<div style="text-align: right"><em>EUR '000</em></div>

| | Note | 2016 | 2015 |
|---|---|---|---|
| *Economic result of the year* | | *(157 393)* | *(284 756)* |
| **Operating activities** | | | |
| *Depreciation and amortization* | | *250* | *282* |
| *(Increase)/decrease in pre-financing* | | *(14 927)* | *20 424* |
| *(Increase)/decrease in exchange receivables and non-exchange recoverables* | | *(53 827)* | *20 460* |
| *Increase/(decrease) in payables* | | *(90 163)* | *(4 668)* |
| *Increase/(decrease) in accrued charges and deferred income* | | *6 792* | *(17 691)* |
| *Increase/(decrease) in cash contributions* | | *145 172* | *101 688* |
| *Increase/(decrease) in in-kind contribuions* | | *153 994* | *153 302* |
| | | | |
| **Investing activities** | | | |
| *(Increase)/decrease in intangible assets and property, plant and equipment* | | *(10)* | *(68)* |
| | | | |
| **NET CASHFLOW** | | **(10 112)** | **(11 028)** |
| | | | |
| *Net increase/(decrease) in cash and cash equivalents* | | *(10 112)* | *(11 028)* |
| *Cash and cash equivalents at the beginning of the year* | *2.5* | *10 129* | *21 157* |
| *Cash and cash equivalents at year-end* | *2.5* | *17* | *10 129* |

## Result of the implementation of the budget

<div style="text-align: right"><em>EUR '000</em></div>

| | Title | 2016 | 2015 |
|---|---|---|---|
| ***Revenue*** | | *132 813* | **101 738** |
| *of which:* | | | |
| *Contribution from the European Union* | *1* | *131 519* | |
| *Contribution from Eurocontrol* | *2* | *–* | |
| *Contribution from other members* | *3* | *–* | |
| *Other revenue* | *4* | *1 294* | |
| | | | |
| ***Expenditure*** | | **(102 973)** | **( 94 367)** |
| | | | |
| *of which:* | | | |
| *Staff expenditure* | *A-1* | *(5 019)* | |
| *Admin expenditure* | *A-2* | *(2 712)* | |
| *Operational expenditure* | *BO-3* | *(95 243)* | |
| | | | |
| ***Exchange rate differences*** | | *(1)* | **–** |
| | | | |
| **Budget result** | | **29 839** | **7 371** |

# Annex IX. Other annexes

## IX.1 List of acronyms and definitions

| Acronym | Long Name / Definition |
|---|---|
| 4 D | 4 Dimensions |
| ABAC | Accrual Based Accounting |
| ACAS | Airborne Collision Avoidance System |
| A-CCD | Advanced Continuous Climb Departure |
| A-CDA | Advanced Continuous Descent Approach |
| ADS-B | Automatic Dependence Surveillance-Broadcast |
| ADS-C | Automatic Dependence Surveillance-Contract |
| ADEXP | ATS Data Exchange Presentation |
| AeroMacs | Aeronautical Mobile Airport Communications System |
| AFUA/ASM | Advanced Flexible Use Airspace/Airspace Management |
| AIM | Aeronautical Information Management |
| AMAN | Arrival Manager |
| AOC | Airlines Operational Communication |
| AOP | Airport Operation Plan |
| ASAS | Airborne Separation Assistance System |
| ASPA | Airborne Spacing |
| ATC | Air Traffic Control |
| ATM | Air Traffic Management |
| ATSA ITP | Air Traffic Situation Awareness- In-Trail Procedure |
| AU | Airspace Users (Civil) |
| CA | Contract Agent |
| CCD | Continuous Climb Departure |
| CDA | Continuous Descent Approach |
| CDM | Collaborative Decision Making |
| CNS | Communication, Navigation, Surveillance |
| CTA | Controlled Time Arrival |
| CWP | Controller Working Position |
| DART | Data-driven Aircraft Trajectory |
| DCB | Demand and Capacity Balancing |
| DCMAC | Directorate Civil Military ATM Coordination (part of EUROCONTROL) |
| DMAN | Departure Manager |

| Acronym | Long Name / Definition |
|---------|------------------------|
| EGNOS | European Geostationary Navigation Overlay Service |
| EOCVM | European Operational Concept Validation Methodology |
| EPP | Extended Projected Profile |
| ER | Exploratory Research |
| EU | European Union |
| FCI | Future Communication Infrastructure |
| GA | General Aviation |
| GA/R | General Aviation & Rotorcraft |
| GANP | Global Air Navigation Plan (from ICAO) |
| GBAS | Ground Based Augmentation System |
| GNSS | Global Navigation Satellite System |
| H2020 | Horizon 2020 Framework Programme |
| HMI | Human Machine Interface |
| I 4D | Initial 4 Dimensions |
| ICAO | International Civil Aviation Organisation |
| IFR | Instrument Flight Rules |
| IOP | Inter-operability |
| IR | Industrial Research & Validation |
| LVC | Low Visibility Conditions |
| LVP | Low Visibility Procedure |
| Members | 2 Founding Members (the European Union and EUROCONTROL) and 19 stakeholder Members of which all apart from the EU are signatory to a Membership Agreement or Accession Agreement |
| MSP | Multi Sector Planning |
| NOP | Network Operation Plan |
| OAT | Operational Air Traffic |
| P-RNAV | Precision Area Navigation |
| R&I | Research & Innovation |
| RNP | Required Navigation Performance |
| RPAS | Remotely Piloted Aircraft System |
| RSP | Required Surveillance Performance |
| RTS | Real Time Simulation |
| S2020 | The SESAR 2020 research and innovation programme, also referred to as the SESAR 2020 Programme or SESAR 2020 R&I programme<br><br>It is the coordinated set of activities described in this document and being undertaken by the Members and managed by the SESAR JU |

| Acronym | Long Name / Definition |
|---|---|
| S&M | Sequencing & Merging |
| SBT/RBT | Shared Business Trajectory/Reference Business Trajectory |
| SES | Single European Sky |
| SESAR | Single European Sky ATM Research |
| SJU | SESAR Joint Undertaking |
| SNE | Seconded National Expert |
| STAM | Short Term ATFCM Measures |
| STCA | Short Term Conflict Alert |
| SWIM | System Wide Information Management |
| SWIM-TI | System Wide Information Management Technical Infrastructure |
| TA | Temporary Agent |
| TMA | Terminal Manoeuvring Area |
| TRL | Technology Readiness Level |
| TTA | Target Time Arrival |
| UAS | Unmanned Aerial System |
| UDPP | User Driven Prioritisation Process |
| UTM | UAS Traffic Management |
| VLD | Very Large-Scale Demonstration |
| VLL | Very Low-Level |

**Table 30: List of acronyms and definitions**

## IX.2    Composition of the Administrative Board as at 31 December 2016

| SJU Founding Members | Member | Alternate |
|---|---|---|
| European Union | Mr. Henrik Hololei (Chair), European Commission | Mr. Margus Rahuoja |
| EUROCONTROL | Mr. Frank Brenner (Deputy Chair), EUROCONTROL Agency | Mr. Philippe Merlo |
| **SJU Members** | **Member** | **Alternate** |
| Airbus | Mr. Bruno Darboux | Mr. Bruno Ley |
| AT-One consortium | Prof. Dr.-Ing. Dirk Kügler | Dr Helmut Többen |
| B4-consortium | Mr. Maciej Rodak | Mr. Lubos Hlinovsky |
| COOPANS | Ms Susanne Isaksen | Mr. Steen Erichsen |
| Dassault Aviation | Mr. Frédéric Falchetti | Ms Catherine Champagne |
| DFS | Mr. Robert Schickling | Mr. Ralf Bertsch |
| DSNA | Mr. Maurice Georges | Mr. Philippe Barnola |
| ENAIRE | Mr. Ignacio González Sánchez | Ms Mariluz de Mateo |
| ENAV | Mr. Iacopo Prissinotti | Mr. Cristiano Cantoni |
| FINMECCANICA | Mr. Stefano Porfiri | Mr. Fabio Ruta |
| Frequentis | Mr. Christian Pegritz | Mr. Michael Holzbauer |
| Honeywell | Mr. George Papageorgiou | Mr. Sander Roosendaal |
| INDRA | Mr. Rafael Gallego Carbonell | Mr. Ramon Tarrech |
| NATMIG | Mr. Aage Thunem | Mr. Magnus Lindegren |
| NATS | Mr. Jonathan Astill | Mr. Dave Curtis |
| SEAC | Mr. Giovanni Russo | Mr. Gérard Battistella |
| Skyguide | Mr. Thomas Buchanan | Mr. Pascal Latron |
| Thales Air Systems SAS | Mr. Luc Lallouette | Mr. Todd Donovan |
| ThalesAvionics SAS | Mr. Philippe Priouzeau | Mr. Pascal Combe |
| **Stakeholder Representatives** | **Member** | **Alternate** |
| Military | Air Commodore (retd) Chris Lorraine, MAB<br>Mr. Jorge Domecq, European Defence Agency | Mr. Per Coulet<br>Mr. Roland Van Reybroek |
| Civil users of airspace | Mr. Simon McNamara, IATA | Mr. Giancarlo Buono |
| Air Navigation Service Providers | Mr. Guenter Martis, CANSO | |
| Equipment manufacturers | Mr. Vincent de Vroey, ASD | Mr. Yoann Viaouet |

| | | |
|---|---|---|
| Airports | Mr. Olivier Jankovec, Airports Council International | Mr. Panos Spiliotis |
| Staff in the ATM sector | Mr. Michele Altieri, ENAV | Mr. Theodore Kiritsis |
| Scientific community | Mr. Peter Hecker, Technische Universität Carolo-Wilhelmina zu Braunschweig | Mr. J.A. Mulder |
| **Permanent Representatives** | **Member** | **Alternate** |
| SJU Executive Director | Mr. Florian Guillermet | n/a |
| SJU Deputy Executive Director | Mr. Peter Hotham | n/a |
| SJU Chief Administration Affairs | Mr. José Calvo Fresno | n/a |
| SJU Internal Audit | Ms. Véronique Haarsma | n/a |
| Secretary of the Board | Ms. Ilaria Vazzoler | n/a |

**Table 31: Composition of the SJU Administrative Board (2016)**

## IX.3 SESAR 1 Close-out Report

# THE SESAR 1 KEY FACTS

**SESAR**
JOINT UNDERTAKING

Aviation, supported by air traffic management (ATM), is a key driver of EU economic growth, jobs and trade, and essential for the life and mobility of its citizens. However, the current ATM system is highly fragmented and reliant on ageing technology, leading to inefficiencies of €4 billion annually. The role of SESAR is to define, develop and deploy what is needed and build a more connected greener, safer ATM system for Europe in aviation and air transport.

## SESAR JOINT UNDERTAKING
A unique public-private partnership, in place since 2007, uniting:

| 2 founding members: EU and Eurocontrol | 19 industry members | 100+ companies from across air traffic | 60+ universities, research centres | 3,000 experts from aviation and ATM |

## OUR ACHIEVEMENTS
Since its establishment, the SESAR JU and members have taken ATM research 'out of the lab' onto real systems and into real-life air traffic operations across Europe and internationally. They have:

Conducted 300 industrial research projects

350 validation exercises

30,000 flight trials

More than 90 industrial prototypes

Over 40 exploratory projects to push the boundaries of knowledge on ATM and aviation

61 new or improved operational procedures and technologies (SESAR Solutions)

## MILESTONES

> The world's first flight in four dimensions (4D-3 spatial dimensions + time) in **2012** and **2014** to enhance flight predictability and therefore punctuality and efficiency.

> In **2013**, the SESAR JU delivered a first set of solutions selected by the European Commission for Europe-wide deployment coordinated by the SESAR Deployment Manager. The **23 solutions** to be deployed between 2015 and 2024 across Europe are expected to deliver approximately **€12.1 billion worth of performance gains for some €3.8 billion of investments**[3]

> The opening in **2014** of the **world's first remote tower facility** in Sweden, serving a location 150 km away. Remote tower services are a means to provide access to remote regions and boost regional economies. Sweden is planning to launch another 12 remote towers in the next years. Germany and Ireland have expressed an interest too.

> In **2015**, the world's first **flight trial of a large civil drone integrated into commercial traffic**.

## OUR FUTURE

> Looking beyond to 2035, the SESAR project could potentially generate recurring benefits ranging from €8 Billion to €15 Billion per year.

> Overall, SESAR promises the following gains[4]:

**Efficiency and predictability**
Up to 6% reduction in flight times and up to 30% reduction in departure delays

**Environment**
Up to 10% reduction in fuel burn and $CO_2$ emissions;

**Capacity**
A system capable of handling up to 100% more traffic, and up to 10% additional flights landing at congested airports

**Cost-effectiveness**
Up to 40% reduction in air navigation services costs per flight

> Or, for an average trip in Europe:

**Safety**
Improved by a factor of 3-4 times coping with traffic increase

20 minutes shorter door-to-door travel time

10kg in fuel savings per passenger

€15 in ticket savings

**It is estimated that for every euro invested in SESAR R&D there is a €6 return-on-investment.**

## NOW LAUNCHING SESAR 2020

> Research and innovation activities will continue under SESAR 2020, with focus on four areas:
  - High performing airports (estimated 25% of 2020 industrial research budget)
  - Advanced air traffic services (24%)
  - Optimised ATM network services (14%)
  - Enabling aviation infrastructure (37%)

> The programme will create an innovation pipeline, moving ideas into industrial research and large scale demonstrations.
  - €20 million will ensure the safe integration of drones into airspace. By 2050, drones will represent a quarter of air traffic.
  - €12-15 million will address cyber security to ensure information can be shared securely among all stakeholders.
  - €85 million will be used to fund exploratory research projects.

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2   Commission Implementing Regulation (EU) No 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan

3   Official proposal on the content of the PCP (edition 1.0), 6 May 2013, SESAR Joint Undertaking. All figures are undiscounted.

4   European ATM Master Plan (2015 edition)

EUROPEAN UNION    EUROCONTROL

**Foreword**

This report reflects the outcomes of the SESAR 1 research and innovation (R&I) programme, which was formally closed at the end of 2016. It endeavours to capture the achievements of this period, report on the use of the funds allocated to the programme, as well as draw lessons and anticipate new challenges in view of a successful implementation of the SESAR 2020 programme starting in 2017. Its reading would be usefully completed by also reading the book "*SESAR - From vision to reality*", which gives a more journalistic view on the SESAR story, as well as the "*SESAR Solutions Catalogue*", which in its first edition (June 2016) draws together in a synthetic way the Solutions delivered by the SESAR Joint Undertaking (SJU) under the SESAR 1 Programme, a materialisation of the concrete SESAR deliveries so far.

## The Single European Sky technological pillar

From the outset and Council Regulation (EC) No 219/2007 of 27 February 2007 establishing the SJU, SESAR was referred to as the technological pillar of the EU's Single European Sky (SES) initiative. The European Commission several times stated that "SESAR is an integral component of the SES and an essential enabler for its implementation". It is expected to define, develop and deploy "a high quality, new generation of air traffic management (ATM) technologies, systems and procedures compliant with SES objectives and requirements"[53]. Therefore, SESAR was, and still is, about defining and developing technology that will bring network and/or local performance gains and contribute to achieving the SES high-level performance goals.

## Supporting the European economy and leadership in aviation

Beyond the Single European Sky, the launch of SESAR should be seen in a much broader context: In an effort to spur growth in the economy, the EU had launched an action plan[54] to unlock the potential of industries, such as aviation - a sector that employs between 1.4 million and 2 million people and overall supports between 4.8 million and 5.5 million jobs in Europe, directly and indirectly. This altogether amounts to over 110 billion EUR of European GDP per year, while the overall impact, including tourism, is as large as 510 billion EUR[55]. A technologically-enhanced and performance-driven ATM system was recognised as a critical element for the sustainability of this sector. Therefore the establishment of SESAR was - and still is - seen as essential to maintaining Europe's position as a leader in aviation.

## A wide international partnership breaking down silos

The creation of the SJU was successful in creating a framework for research cooperation breaking down "silos" and bringing together all ATM stakeholders from airspace users, air navigation service providers, the Network Manager, airports, manufacturers, the military, professional staff associations, research institutes and the academia, all this in connection with all the other key

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[53] Commission staff working paper on preparing a deployment strategy for the SES technological pillar, 10.12.2010 SEC(2010) 1580 final

[54] The "Lisbon Strategy", adopted by the European Council in 2000 and reviewed in 2004.

[55] Source: European Commission, an Aviation Strategy for Europe http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2015:598:FIN

European ATM institutions such as the European Commission, EASA, EUROCONTROL, EUROCAE, as well as the SES Performance Review Body.

## Time to implement

After six years of operation and successful completion of the definition phase and of a first phase of development, time had come to start delivering concretely. The European Commission set up in 2013 a deployment strategy materialised by the Commission implementing Regulation "*on the definition of common projects, the establishment of governance and the identification of incentives supporting the implementation of the European Air Traffic Management Master Plan*"[56]. In accordance with Article 3 of this Regulation, the Master Plan gained legal importance and became "*the roadmap driving the modernisation of the European ATM system and connecting SESAR research and development with deployment. It shall be the key SES instrument for the seamless operation of the EATMN[57] and the timely, coordinated and synchronised SESAR deployment*".

In recent years, through the SESAR Release process, a growing number of Solutions have been delivered to the aviation community, as outlined in the SESAR Solutions Catalogue. SESAR R&I delivers concretely, and the pipeline between R&I and deployment is open.

It is from these Solutions that were selected and extracted the ATM functionalities that composed the Pilot Common Project adopted in June 2014 by the European Commission[58]. This Pilot Common Project is now being deployed by operational stakeholders under the responsibility of the SESAR Deployment Manager. Beyond this, the SESAR 1 Programme has continued delivering and more Solutions are on their way.

## SESAR 2020: A new impetus

Almost simultaneously to the European Commission adoption of the Pilot Common Project, the EU Council of Ministers adopted the extension of the SJU up until 2024, to "*continue the development of the activities defined in the ATM Master Plan*" ('the SESAR 2020 programme) and "*allow for the execution of the whole ATM Master Plan as it stands today*"[59].

In December 2015 the SJU Administrative Board adopted a new edition of the European ATM Master Plan, and  the Commission unveiled its "*Aviation strategy for Europe*"[60] calling for a strengthening of European aviation through research, innovation and investment and, in particular, the modernisation of ATM through the delivery of Solutions developed through SESAR R&I.

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[56]  Commission implementing Regulation (EU) No 409/2013 of 3 May 2013

[57]  EATMN: European ATM Network

[58]  Commission implementing Regulation (EU) No 716/2014 of 27 June 2014

[59]  Council Regulation (EU) No 721/2014 of 16 June 2014 amending Regulation (EC) No 219/2007 on the establishment of a Joint Undertaking to develop the new generation European air traffic management system (SESAR) as regards the extension of the Joint Undertaking until 2024.

[60]  7.12.2015, SWD(2015) 261 final

**What is in the report?**

In such challenging but also stimulating context, 2016 has been a crucial year which saw the closure of the SESAR 1 programme and the transition towards the start of the SESAR 2020 programme. The purpose of this document is to:

1. Highlight the added value brought so far by the SESAR project at the closure of SESAR 1;

2. Report on the use of the funds allocated to SESAR 1 and assess the return on this investment;

3. Look back on the initial expectations from SESAR, assess to what extent they were fulfilled and outline the lessons to be drawn for SESAR 2020.

### IX.3.1 What is the added value brought by the SESAR 1 programme?

The added value brought by the SESAR programme to the European ATM is twofold. It consists in:

1. Defragmentation: A robust and collegial governance model, securing wide stakeholders' buy-in, including the military, and close oversight by National and European Regulators;
2. Solution-oriented delivery approach: An innovation pipeline covering from exploratory research to deployment-readiness and a "factory" that generates the delivery of substantial R&I results mature for deployment and bringing measurable ATM performance gains.

This is developed in the present Chapter.

### IX.3.1.1 Working together: establishing a unique cooperative innovation platform

When the SJU was established in 2007[61], the landscape of the European ATM Research & Innovation looked very different. It was composed of a series of silos of knowledge and research projects, with experts and researchers often duplicating one another's efforts - a very costly and non-productive affair. This approach not only stifled excellence in the field, it also led to areas of ATM being addressed in isolation from one another, thereby missing out on important interdependencies and synergies. By the time SESAR started, stakeholders had done as much as they could individually, but it was clear that this fragmented approach could not bring about the modernisation in ATM that Europe very much needed.

Therefore, the first task for the SJU after its creation was to federate and pool the knowledge and resources of the entire ATM community so as to together define, develop and validate the technology solutions ("SESAR Solutions") that would modernise the ATM system.



**Figure 14: The original SESAR membership**

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[61]  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)

To define and develop technological solutions in partnership is essential for three main reasons:

1. The first is to understand what is possible. Innovative ideas need to be confronted with reality checks by industry and investors, who may have different ideas and interests. Early discussion and partnership allows verifying the potential of the idea, and early identification of the possible need of evolution of business models.

2. The second critical element is to secure investors' buy-in at an early R&I stage. At the end of the day they will have to invest to implement the technological changes. Engaging them in R&I activity in the definition and development of the innovative concept is essential to convince them of the benefits that they can expect.

3. The third element is to better connect innovation with policy-making.

The implication of SESAR Members was widespread through Membership in all the key governance bodies of the Programme:



**Figure 15: A truly collaborative process**

- The SESAR JU Administrative Board, the top level governance and decision-making body of the Programme, associating all SJU Members and chaired by the European Commission.
- The Programme Committee, participating in the steering of the Industrial Research Programme and supporting the SJU Executive Director.
- The Programme Control Group, a consultative body supporting the SJU in the operational management of the Programme.

The implication of SESAR partners was also achieved through participating in, and even actually managing, individual projects.

This thorough stakeholder implication at all stages of the programme allowed a much smoother transition from R&I to deployment and much higher take-up of results than in the pre-SESAR context. It can safely be said that, without the permanent partnership secured by the public-private partnership (PPP) structure, a number of valuable solutions would probably have stayed on the shelf or transited only slowly and in a local and uncoordinated way to implementation.

### IX.3.1.2 Public oversight to ensure the optimal use of public and industry funding

The provisions of Article 7 of Council Regulation (EC) No 219/2007 requested the European Commission (EC) to evaluate the implementation of the regulation every three years, focusing on "*the results obtained by the Joint Undertaking and its working methods, as well as the financial situation of the Joint Undertaking*", and to "*present the results of these evaluations to the European Parliament and to the Council.*" A "mid-term study" was therefore conducted in July 2010, under the authority of the European Commission. The results of this evaluation were that "*The JU Public Private Partnership model has proven more effective and efficient than if the SESAR programme was implemented as a demand-driven FP7 R&D programme through calls for proposals. The FP7 approach would not in the same way be able to avoid fragmentation of activities*"[62].

The Mid-term study confirmed the added value of the PPP model and its governance structure. This is particularly true now that technology deployment is on its way: the involvement of the industry allows securing buy-in and commitment of stakeholders to the decisions taken and therefore coordinated and synchronised actions across the European network. The public oversight, in particular from the European institutions allows ensuring the best possible use of the public money injected in the programme.

### IX.3.1.3 A strong policy connection: the European ATM Master Plan to drive priorities

The European ATM Master Plan (the "Master Plan") is "*the roadmap driving the modernisation of the European ATM system and connecting SESAR research and development with deployment. It shall be the key SES instrument for the seamless operation of the EATMN and the timely, coordinated and synchronised SESAR deployment*"[63].

A look at the three successive Editions of the Master Plan allows identifying a steady evolution towards streamlining and prioritising efforts in a performance-based approach, supporting efficient processes and the delivery of benefits for the aviation community, in line with the SES High-Level goals.

The first Master Plan Edition, in 2009, needed to achieve the challenge of bringing together and federating all the actors of the European ATM. To secure buy-in, it had in a way to assemble together all the existing projects with only basic filtering. Deliverable 6 from the Definition phase – Work programme for 2008-2013 – was describing the work breakdown into about 300 Projects without prioritisation.

Whilst this first Master Plan was already presented as built on a performance-based approach, it presented seven key performance areas (Capacity, Cost-effectiveness, Efficiency, Flexibility, Predictability, Safety and Environmental sustainability) and 33 Key

> *'The first Master Plan may have been overly ambitious; however, it provided a guarantee to industry that investing in the technology was worthwhile since it would be implemented within an agreed regulatory framework. This is a real strength that comes out of connecting the institutional side with the research, development and deployment.'*
>
> **Patrick Ky,** Former Executive Director of the SJU (2007-2013) and Executive Director of the European Aviation Safety Agency

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[62]  Mid-term evaluation of the SJU (TREN/A2/143-2007), final report, July 2010

[63] Commission implementing Regulation (EU) No 409/2013 of 3 May 2013

Performance Indicators (KPIs)[64]. These indicators were in fact the aggregation of the tailor-made indicators developed in a bottom-up manner by each project for their own needs. They were hardly cross-readable and, as they were defined before the SES Performance Scheme was put in place, also hardly compatible with the indicators later defined in implementing Regulation (EU) No 691/2010 of 29 July 2010, the first Regulation establishing the SES performance scheme[65].

As the scope or R&I was extending and its content was refining, thus further increasing the number of Operational Improvements, the 2012 Master Plan demonstrated a strong effort to streamline, focus and prioritise, setting the foundations upon which the European Commission could build its deployment Strategy. The Operational Improvements were grouped into 11 "essential operational changes" and 24 "operational changes" and broken down into 6 Key Features, as shown in the figure below, extracted from the Master Plan document.



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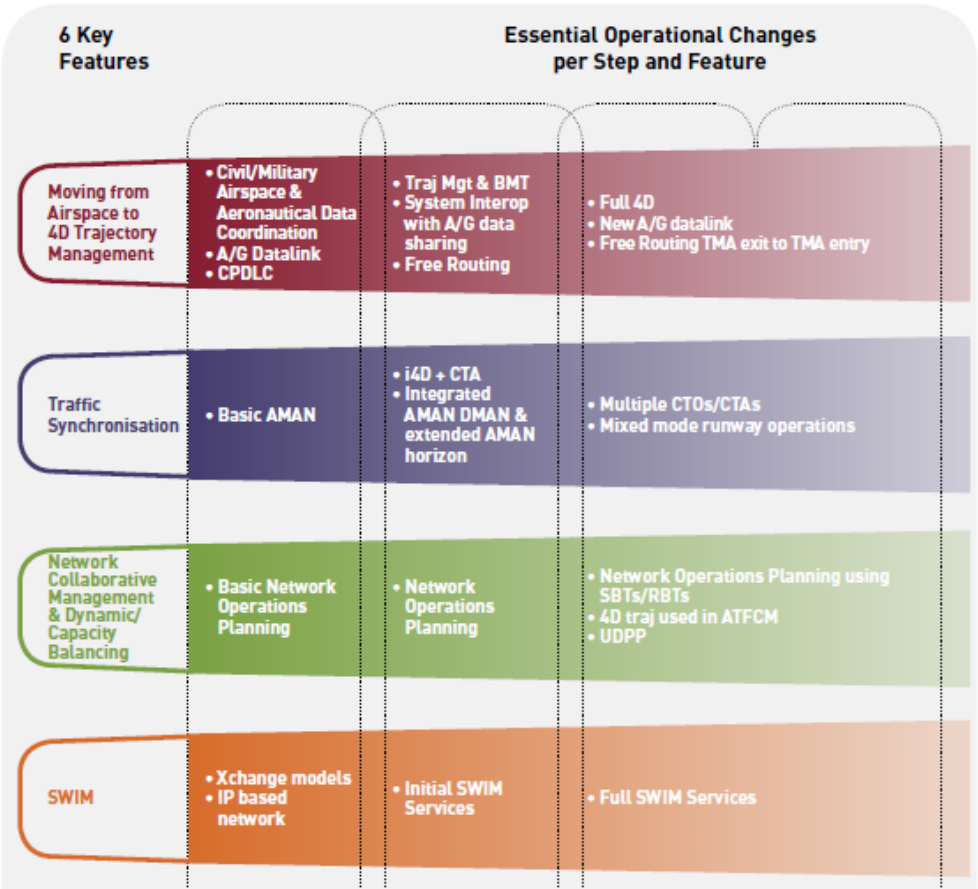
[64] Master Plan Ed 2009, Table 1

[65] Subsequently repealed by  IR (EU) No 390/2013 of 3 May 2013
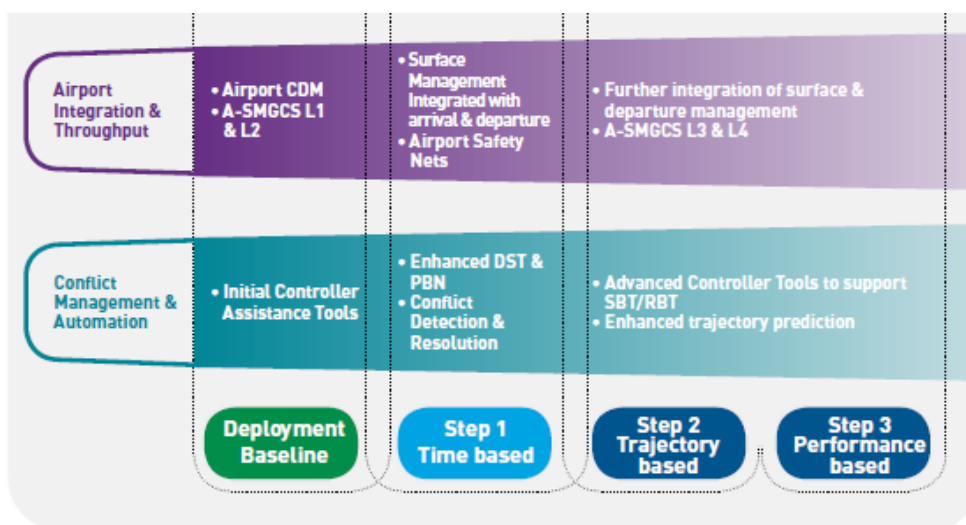
**Figure 16: Mapping of Essential Operational Changes to the Key Features (Master Plan Ed. 2, 2012)**

The essential operational changes were identified on the expectation that they would provide significant benefits and/or form a prerequisite towards the implementation of the target concept. This "Essential" concept was used by the European Commission when defining the elements from which were to be selected the ATM functionalities composing the European Commission common projects.

In line with Implementing Regulation (EU) No 409/2013, the criteria for selecting the essential operational changes to become part of a common project were threefold: Proven maturity, performance benefits at network level, and need for synchronised deployment.

On the basis of these criteria, a subset of the 2012 Essential operational changes was selected to constitute the ATM functionalities of the Pilot Common Project, decided in Commission implementing Regulation (EU) No 716/2014. Simultaneously, the 2012 Master Plan Edition endeavoured to narrow the gap between the SESAR performance indicators and the ones of the performance scheme. The same Key Performance Areas of safety, capacity, environment and cost-efficiency were used, but the indicators and metrics were still not fully compatible[66].

The additional efforts needed were then made in the 2015 Master Plan, embedding even more firmly the technological pillar into the SES and ensuring the convergence of the SESAR Key Performance Areas (KPAs) and indicators towards the SES performance scheme. As indicated in the figure below, most key performance indicators in the 2015 Master Plan are now mapped with the SES performance scheme indicators, and either identical or as a minimum "cross-readable". This was a must to be able to highlight SESAR's contribution, to achieving the EU-wide targets as requested by the Commission implementing Regulation[67].

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[66] Master Plan Edition 2012, page 19

[67] Article 3(2) of Commission implementing Regulation (EU) No 409/2013 on SESAR Deployment and common projects

Founding Members

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In addition, a limited number of performance areas and indicators have been deemed useful to create or maintain, even if not currently covered by the performance scheme: This includes e.g. the noise and local air quality in the key performance area of environment, or the "operational efficiency", with the indicators of fuel burn and flight time per flight. Contact is being made with the Performance Review Body of the European Commission to identify whether such areas and indicators could be possibly inserted in an evolution of the performance scheme or at least used for monitoring.

| Key performance area | SES High-Level Goals vs. 2005 | Key performance indicator | SESAR ambition vs. baseline 2012 | |
|---|---|---|---|---|
| | | | Absolute saving | Relative saving |
| Cost efficiency: ANS productivity | Reduce ATM services unit cost by 50% or more | • Gate-to-gate direct ANS cost per flight<br> - Determined unit cost for en-route ANS*<br> - Determined unit cost for terminal ANS* | EUR 290-380 | 30-40% |
| Operational efficiency | - | • Fuel burn per flight (tonne/flight)<br>• Flight time per flight (min/flight) | 0.25 -0.5 tonne<br>4-8 min | 5-10%<br>3-6% |
| Capacity | Enable 3-fold increase in ATM capacity | • Departure delay (min/dep)<br> - En-route air traffic flow management delay*<br> - Primary and reactionary delays all causes<br>• Additional flights at congested airports (million)<br>• Network throughput additional flights (million) | 1-3 min<br><br><br>0.2 -0.4 (million)<br>7.6 -9.5 (million)<br>Additional flights, not saving | 10-30%<br><br><br>5-10% [1]<br>80-100% [2] |
| Environment | Enable 10 % reduction in the effects flights have on the environment | • CO$_2$ emissions (tonne/flight)<br> - Horizontal flight efficiency (actual trajectory)*<br> - Vertical efficiency<br> - Taxi-out phase | 0.79 -1.6 tonne | 5-10% |
| Safety | Improve safety by factor 10 | • Accidents with ATM contribution | No increase in accidents | Improvement by a factor 3-4 |
| Security | - | • ATM related security incidents resulting in traffic disruptions | No increase in incidents | |

Metrics with monetary value in business view

* Targeted by the Performance Scheme

1. 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).

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

Source: Eurocontrol PRB, SES, EC ACE report (2012), Master Plan Campaign Expert Workshops.

**Figure 17: The SESAR Performance ambitions for 2035, categorised by Key Performance Area**

With the 2015 Master Plan further steps have been taken towards streamlining and focusing R&I efforts on solutions that can actually deliver performance and pave the way towards realising SESAR's vision for 2035: 12 new essential operational changes have been highlighted, building on those selected for the Pilot Common Project and identifying the next operational changes likely to bring substantial network performance improvement.

Until the next update of the Master Plan, this list of new Essential Operational Changes will be the source from which may be selected the components of the next common projects. They are classified in accordance with 4 Key Features and the concept of Steps is abandoned for a more continuous phasing in of the next technologies. This is shown in the following figure:

| SESAR Key Features | Pre-SESAR | Essential Operational Changes | | Key R & D activities |
| | | PCP | New | |
|---|---|---|---|---|
| **Optimised ATM network services** | • ATFM slot exchange<br>• Civil/military airspace and aeronautical data coordination<br>• Basic network operations planning<br>• STAM | • ASM and A-FUA<br>• Automated support for traffic complexity assessment<br>• Collaborative NOP<br>• CTOT to TTA for ATFCM purposes<br>• Enhanced STAM<br>• Free route | • UDPP | • Management of dynamic airspace configurations<br>• Integrated local DCB processes<br>• Network prediction and performance<br>• Collaborative network management functions<br>• Mission trajectory driven processes<br>• AU processes for trajectory definition<br>• AU trajectory execution from FOC perspective<br>• AU fleet prioritisation and preferences |
| **Advanced air traffic services** | • Basic AMAN<br>• Introduction of PRNAV<br>• Provision of ATSA-AIRB | • AMAN extended to en-route airspace<br>• Enhanced TMA using RNP-based operations<br>• Free route | • Advanced RNP<br>• AMAN/DMAN integration Including multiple airports<br>• Trajectory-based tools<br>• Sector team operations | • Flight- and flow-centric ATC<br>• High productivity controller team organisation<br>• Collaborative control<br>• Improved performance in the provision of separation<br>• Advanced separation management<br>• IFR RPAS integration<br>• Dynamic and enhanced routes and airspace<br>• Enhanced rotorcraft and GA operations in the TMA<br>• Ad hoc delegation of separation to flight deck<br>• Enhanced airborne collision avoidance for commercial air transport normal operations - ACAS Xa<br>• Use of arrival and departure management Information for traffic optimisation within the TMA<br>• Generic (non-geographical) controller validations |
| **High-performing airport operations** | • Initial airport CDM<br>• A-SMGCS L1 and L2<br>• Crosswind reduced separations for arrivals<br>• Operations in LVC | • TBS for final approach<br>• Automated assistance to controller for surface movement planning and routing<br>• Airport safety nets<br>• DMAN synchronised with pre-departure sequencing<br>• DMAN integrating surface management constraints<br>• Airport operations plan | • LVPs using GBAS<br>• Collaborative airport<br>• Integrated surface management<br>• Integrated surface management datalink | • Wake turbulence separations optimisation<br>• Enhanced arrival procedures<br>• Independent rotorcraft operations at the airport<br>• Traffic optimisation on single and multiple runway airports<br>• Traffic alerts for pilots for airport operations<br>• Enhanced airport safety nets for controllers<br>• Surface operations by RPAS<br>• Enhanced collaborative airport performance management |
| **Enabling aviation infrastructure** | • IP network<br>• B2B services<br>• Information reference and exchange models<br>• A/G datalink<br>• ADS-B, WAM<br>• GNSS, GBAS, SBAS | • Common Infrastructure Components: SWIM registry, PKI<br>• SWIM technical infrastructure and profiles<br>• Aeronautical information exchange<br>• Meteorological information exchange<br>• Cooperative network information exchange<br>• Flight information exchange<br>• Initial trajectory information sharing (i4D) | • CNS rationalisation<br>• Information sharing and business trajectory<br>• Mission trajectory | • Integration of trajectory management processes in planning and execution<br>• Performance-based trajectory prediction<br>• Enhanced mission trajectory<br>• Management and sharing of data used in trajectory (AIM, meteo)<br>• Work station, service interface definition and virtual centre concept<br>• SWIM TI purple profile for A/G advisory information sharing<br>• Airborne D&A systems supporting integrated RPAS operations<br>• FCI terrestrial datalink<br>• Future satellite communications datalink<br>• GA/RC specific CNS systems<br>• GBAS<br>• Multi-constellation/multi frequency GNSS<br>• Alternative position, navigation and timing |

**Figure 18: The SESAR Key Features (Figure 9 of Ed. 2015 of the Master Plan)**

### IX.3.1.4 The SESAR factory: Overcoming R&I fragmentation and delivering the Solutions

The SESAR 1 programme is composed of more than 320 industrial research projects, about 40 Exploratory Research projects and 38 demonstrations. Those projects are part of the SESAR "Innovation pipeline" which represents a sequence of events enabling the research and development of "SESAR Solutions" (described in Paragraph 0 below), from their initial definition to their confirmed readiness for further industrialisation and deployment, with the aim of achieving the strategic objectives set in the ATM Master Plan.
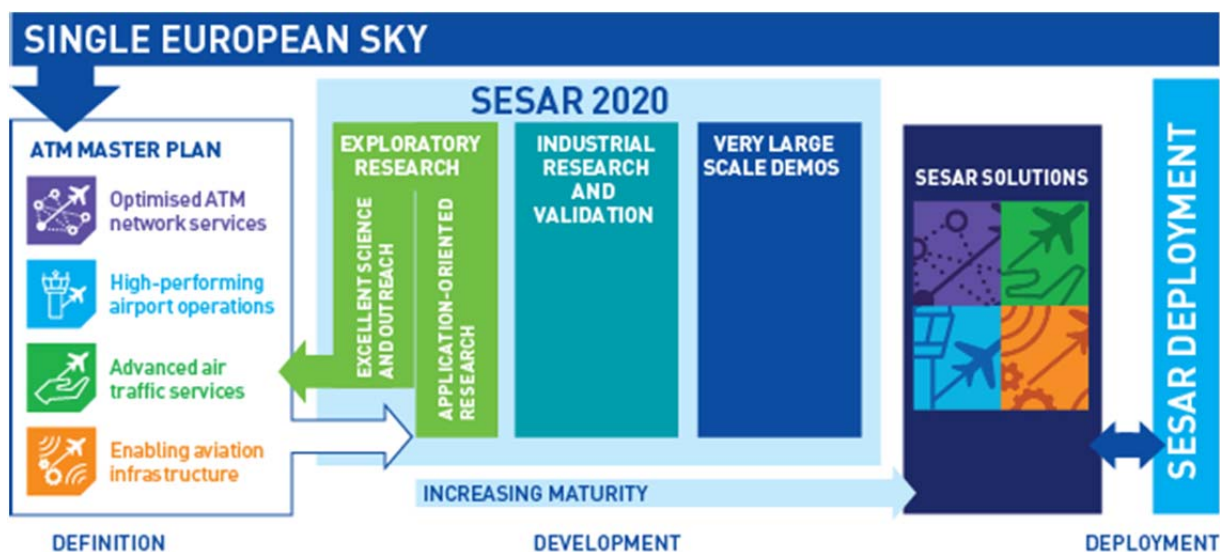
**Figure 19: The SESAR Factory**

The "SESAR Factory" starts from the Master plan, which sets the performance ambition, the operational improvements and enablers, and a high-level development and deployment timeline.

At programme level, performance and validation targets are set, the concept and architecture is developed, operational and technology Solutions development start being developed and, along this work, the initial identification of standardisation and regulatory needs takes place.

At individual project level, operational requirements are set, system prototypes developed, validation activities performed and the results are mainstreamed and packaged to enable deployment.

### IX.3.1.4.1 The innovation pipeline

Directly derived from the European ATM Master Plan and its Key Features, the SESAR 1 programme activities are structured in three main research phases that aim to deliver a pipeline of innovation, which matures operational and technology solutions through the EOCVM (European Operational Concept Validation Methodology), a well-established control and monitoring process linked to Technology Readiness Level (TRL).

1. The first phase concerns Exploratory Research, itself further categorised into those elements/projects dealing with relevant fundamental scientific subjects and those which investigate initial applications for the ATM sector. The exploratory research, a domain in itself, is further detailed in paragraph 0;

2. The second phase includes applied research, pre-industrial development and validation projects and is delivered by the Members of the SJU. Industrial research and validation (IRV) activities facilitate the migration of ideas from Exploratory Research and have them further extended in the applied research phase and finally to pre-industrial development, validation, large scale demonstration and then final preparation for deployment. Therefore the main objective of this strategic area is to deliver SESAR

Solutions derived from the ATM Master Plan and identified in the SJU's multi-annual work programme[68].

3. The third phase deals with Demonstrations, which are designed as demonstrations of particular programme concepts elements and SESAR Solutions. These demonstrations provide the bridge between the development and deployment phases of SESAR through open calls to ensure the widest possible stakeholder participation, including end-users.
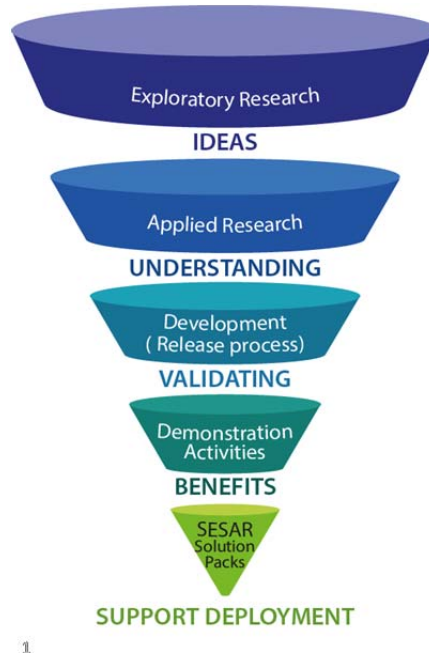


**Figure 20: The innovation pipeline**

With validation sites across Europe, the SJU and its members have taken R&I out of the lab and connected it with the real world. Validations take place in simulation platforms, on board commercial flights, dedicated airport testbeds and air traffic control centres. Exercises are not limited to a specific location, but can be used to test multiple environments irrespective of the location where the physical validation is held.

At the moment of preparing this closure report, over 350 validations have taken place, where pilots, controllers, engineers and other operational staff have worked with SESAR projects to put the solutions to the test.

The outcome of the validation activities is assessed and materialised in the context of the Release management process, which is the yearly process validating SESAR Solutions and setting their operational feasibility and readiness for industrialisation.

> *Stakeholders and engineers understand that our involvement, especially in validations, is essential to achieve the right outcomes, understanding that the contact with reality can best be provided by everyday users.*
>
> **Michele Altieri**, SESAR Focal Point, the Air Traffic Controllers European Unions Coordination (ATCEUC) organisation

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[68] Edition 1.0, 01 July 2015

### IX.3.1.4.2 SESAR delivers: The Release process

 As a performance-based programme, SESAR systematically validates the work of its technological and operational projects through its annual Release process. This process involves solutions having undergone pre-industrial development and integration testing within a given timeframe in operational environments establishing their readiness for industrialisation and subsequent deployment.

Since 2011, when SESAR Solutions started reaching maturity, SESAR has been issuing one release every year:

- Release 1 (2011-2012) presented 7 mature SESAR Solutions: Precision Navigation (P-RNAV) in a complex TMA, validation of LPV, ATC procedures and ATC training, en-route traffic organiser for ATC controller, enhanced short-term conflict alert for TMA specific operations, enhanced airborne collision avoidance system (ACAS), DMAN baseline for integrated AMAN-DMAN, and CWP airport – low cost and simple departure data entry panel.

- Release 2 (2012-2013) presented 3 mature SESAR Solutions (Time-based separation, Automatic support for dynamic sectorisation, Single airport remote tower) as well as 5 "quick win" mature Solutions: User preferred routing, Multi-sector planning (NATS), AOC data increasing trajectory prediction accuracy, Point merge at CDG Paris and Point merge in complex TMA.

- Release 3 (2013-2014) presented 3 mature SESAR Solutions: Enhanced short-term conflict alert (STCA) enriched with downlinked aircraft data, Enhanced ground controller situational awareness in all weather conditions, and remote air traffic services for a single airport with low density traffic (remote tower).

- Release 4 (2014-2015) presented 7 mature SESAR Solutions: Extended arrival management (AMAN) horizon, Enhanced terminal operations with LPV procedures, Remote tower for two low-density aerodromes, Pre-departure sequencing supported by route planning, Flow-based integration of arrival and departure management, and Precision approaches using GBAS CAT II/III based on GPS L1. It also reported on a locally-implemented Solution: User-Driven Prioritisation Process (UDPP) departures at Paris CdG.

- Release 5 (2015-2016) was split into two batches. At SESAR 1 closure date, it resulted in 36 Solutions, including 14 Solutions related to the Pilot Common Project, validated as ready for pre-industrialisation. Release 5, the last Release issued under the SESAR 1 Programme, will have delivered in one year more than half of the SESAR 1 Solutions.

After delivery through the Release process, a gap analysis is conducted. This results in feedback loops allowing updating and refining the ATM Master Plan, the Integrated Roadmap, Release Strategy, Validation Strategy and V&V Roadmap.

The output of the Programme is packed in the form of SESAR Solutions, which are further described below.

### IX.3.1.4.3 Handing over the SESAR Solutions to the stakeholders and industry

The "SESAR Solution" is the reference element of SESAR R&I. It refers to new or improved operational procedures or technologies that aim to contribute to the modernisation of the European and global ATM system. All SESAR Solutions seek to demonstrate clear business benefits for the ATM sector when implemented by European ATM stakeholders and serve to articulate the operational

and technological improvements developed within the wider context of each key feature. Each solution is accompanied by a range of documentation ("Solution Packs"), including:

- Operational services and environment descriptions;

- Safety, performance and interoperability requirements;

- Technical specifications;

- Regulatory recommendations;

- Safety and security assessments;

- Human and environmental performance reports.

SESAR Solution Packs are published on the SESAR Solution portal, on the SESAR external website (www.sesarju.eu/solutions).

The Solution Packs enable the entire ATM community to actively explore how they can best benefit from SESAR Solutions, according to their own needs, to ensure that these innovative solutions become a reality.

The current number and status of the SESAR Solutions is depicted in the figure below:
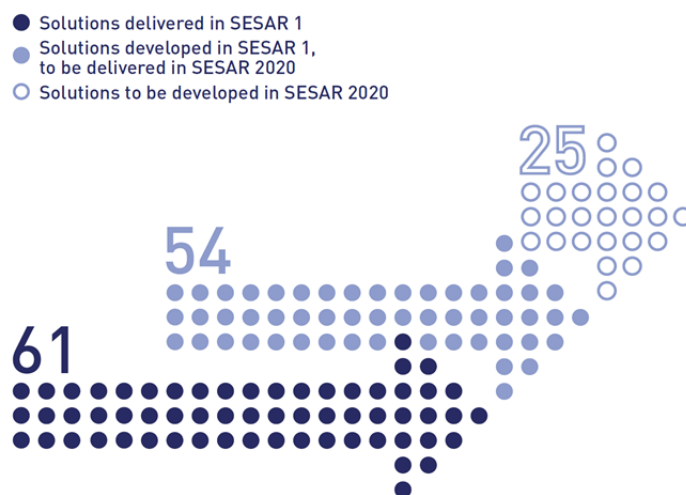


**Figure 21: The SESAR Solutions**

The first Edition of the SESAR Solutions Catalogue[69], published in June 2016, showed for SESAR 1 a list of 63 "SESAR Solutions" that would be delivered in SESAR 1 context. Further work carried out up to the time of finalising this report refined this list to a total of *61 mature Solutions* to be delivered at the end of SESAR 1, 25 being delivered between Releases 1 to 4, and 36 being delivered in two batches of Release 5 in 2016. The full list of these SESAR 1 mature Solutions is to be found in 0, classified per Key Feature and per Release.

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[69] http://www.sesarju.eu/newsroom/brochures-publications/sesar-solutions-catalogue

20 Solutions address the SESAR Key Features of "High Performing airports", 21 "Advanced Air Traffic services", 8 "Optimised ATM network Management", and 12 "Enabling aviation infrastructure" (of which 6 Solutions are dedicated to the Communications, Navigation and Surveillance – CNS – domain). This will be completed by a first wave of 7 very large scale demonstrations[70]. 23 of these 61 Solutions delivered by SESAR 1 are related to the Pilot Common Project.

In addition *54 Solutions* have been initiated under SESAR 1 but will reach their V3 maturity under SESAR 2020 only, and *25 Solutions* are expected to start their development under SESAR 2020.

The 61 Solutions delivered as mature within SESAR 1 lifetime address all parts of the ATM value chain, from airports, air traffic services to the network, as well as the underlying systems architectures and technological enablers. They have undergone about 350 validations exercises and 30,000 flight trials, proving that they work not only on paper, but in real day-to-day operations and are operationally acceptable and beneficial to those who use them.

### IX.3.1.4.4        Implementing the SESAR Solutions

A number of the SESAR solutions have already been taken up by European ATM actors, who are preparing them for implementation.  A notable example is SESAR Remote Tower Services, for which LFV, the Swedish ANSP, recently obtained a license to operate at a Swedish airport - a world first. Small or local airports are lifelines to local and regional economies, generating mobility of goods, services and people. SESAR's Remote Tower Services offers new possibilities for places where it is too expensive to maintain and staff conventional tower facilities and services, or at airports where such services are currently unavailable.

> *In a complex space like the airport, everything is connected and every communication and decision has a consequence. From the very beginning, SESAR has been working to empower airports effectively as ground coordinators — an ambition fully shared and supported by us at ACI EUROPE.'*
>
> **Olivier Jankovec,** Director General, ACI EUROPE

Other examples of the uptake of solutions include London Heathrow and Paris Charles de Gaulle, two of Europe's largest airports, which opened an Airport Operating Centre (APOC). Heathrow furthermore implemented Time Based Separation, and these two concepts were developed in SESAR and aimed at optimising airport operations. The example of Heathrow may prompt the uptake of this or other SESAR concepts and solutions by other airport actors in Europe.  Meanwhile, through the SESAR SWIM Master Classes, which took place on an annual basis from 2012 to 2015, an increasing number of  participating companies are coming together to show the SESAR System Wide Information Wide (SWIM) concept offers real benefits in terms of ATM services and applications. But the most significant milestone so far has been the world's first flights in four dimensions (3D + time), a development which enhances end-to-end trajectory information exchange, bringing us more predictable flights.

Many more individual milestones like these are in the pipeline. But perhaps the most convincing proof of the readiness of SESAR R&I is the decision by the European Commission to package a first

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[70] Multiannual Work Programme, version 1.0 of 2 July 2015

set of SESAR Solutions into the Pilot Common Project (PCP). These will globally bring performance gains in the order of 12 Billion EUR for the period, as detailed in Paragraph 0 below. The deployment will be managed by the SESAR Deployment Manager, an alliance of European ATM actors.

In SESAR 2020 and next Releases, the SJU will build on the solutions included in the first SESAR Solutions catalogue to achieve further progress in the development, validation and delivery of solutions in line with the European ATM Master Plan. With the SESAR Vision as a long-term goal, the focus in the next years will be on further integration of airports into the air traffic network, the implementation of advanced air traffic services such as satellite-based navigational aids, integrated arrival and departure management tools, free route airspace, and optimising network services through increased dynamic data sharing between airlines and air traffic control. New technical and operational solutions as well as other important evolving challenges, such as the integration of remotely piloted air systems into controlled airspace and cyber-security, will also be covered.

### IX.3.1.5 *Exploratory research: pushing boundaries of knowledge*

Exploratory research is the starting point of the SESAR innovation pipeline, as explained in Paragraph 0. Indeed, one of the most innovative aspects of the SJU was the decision to run exploratory research side by side with industrial research. In doing so, the partnership has sought to push the boundaries of our knowledge and understanding of what is possible in the future ATM system. This led to the creation of a strong body of knowledge in SESAR 1 that is now serving the ATM community beyond the framework of SESAR, and will be precious in the frame of SESAR 2020.

Under SESAR 1, exploratory research has taken place within an interdisciplinary work package aiming at addressing long-term ATM R&I challenges. This approach enabled researchers to develop ideas, concepts and technologies, introducing knowledge from other non-ATM disciplines (e.g. complexity science, physics, economics, etc.) and applying it to the ATM domain.

Exploratory research aimed to stimulate scientific research into ATM through the funding of both research projects and research networks. It aimed to address common ATM research challenges related to:

- proving the feasibility of fully automating parts of the ATM system
- demonstrating the feasibility of introducing complex-systems methods to ATM
- defining suitable performance metrics for ATM from a complex-system theory point of view
- the ATM design of the future
- the prospect of an open-source ATM
- assessing performance benefits
- the application of economic incentives

A total of 40 projects have received funding with a budget of approximately 23 million EUR through two calls. A first call resulted in 18 projects running from 2010 to 2013, whilst a second call led to the selection of 22 projects, the results of which were delivered by the end of 2015.

In addition to these projects, three research networks were created, covering automation, complexity science and legal challenges in ATM. The networks actively coordinate the research activities through managing 20 PhD research activities, conferences, summer university courses, workshops and writing position papers based on state-of-the art information available from all research sources.

This long-term and innovative research bore fruit and delivered a useful body of work in a number of crucial domains:

Founding Members

- Trajectory prediction: The projects have demonstrated how mathematical modelling can be used to support 4D trajectory planning. One of the projects included meteorological data and assessed the impact of disruptions.
- Conflict detection: An extension of trajectory planning is medium and long-term conflict detection. A particular strength of the research has been to consider conflicts on arrival and departure in terminal areas, combining real data, simulations and extrapolations to propose resolution and mitigation for potential conflicts.
- Constraint management: Research managed the fusion of multiple mathematical, computational and modelling approaches to constraint management. It compared different approaches in terms of indicators that matter to stakeholders and the travelling public. In some cases, the approaches searched for Pareto optimal solutions. Others looked for equitable approaches that were able to trade off the key stakeholder perspectives.
- Resilience and Human Factors Engineering: As the level of automation is increased to deal with increasingly complex problems, significant human factors challenges will be met (E.g. for the allocation of responsibility between automated and ATC control, or for ensuring resilience both to system failure and to human error). Research has provided significant insights into these issues and also proposed a number of potential solutions.
- Stochastic modelling in ATM: This area explored the development of techniques to frame the uncertainty that is inherent in future air traffic management. Uncertainty and non-determinism arise from the complexity of individual systems and the interaction of multiple, distributed systems. Research has delivered approaches to represent, and reasoning about, uncertainty through stochastic modelling and through the analysis of trust in future ATM systems.
- Enabling Change in ATM: The economics-related projects are of strong relevance in the context of SES Regulation and focusing on adapting demand to capacity. Research delivered surprisingly rich results given the relatively small magnitude of projects.

The results of these projects are being fed into the SESAR 2020 exploratory research activities, thus sustaining and further driving the development of innovative and unconventional ideas, and contributing to the successful evolution of the European ATM system.

Furthermore, exploratory research shall continue on a larger scale under SESAR 2020 as its budget has almost quadrupled to 85 million EUR, ensuring continuation and amplification of SESAR 1 effort, thus allowing Europe to remain at the forefront of aviation innovation.

### IX.3.1.6 Overcoming challenges through dialogue and a collegial approach

The benefit of the PPP can also be perceived in the facilitation of the resolution of problems linked to broader SES context. Early identification of difficulties and a collegial approach to solution- finding and implementing allows overcoming problems in a much more efficient way than a piecemeal and fragmented approach. Not only all stakeholders categories are represented in the SJU Membership (Airspace users, airports, air navigation service providers, manufacturing industries, professional staff associations, R&I community, regulators and military) but the day-to-day SJU activities also involve all key players of ATM (pilots, ATCOs, engineers, support staff) as well as international organisations (EASA, EDA, ESA, in addition to the founding Members European Commission and EUROCONTROL). This ability to gather and mobilise quickly all key players to resolve together and issue has proven very effective.

Two examples deserve to be particularly highlighted:

1. The deployment of datalink:

Very serious difficulties were created by the problems encountered by stakeholders to deploy Datalink technology as mandated by Commission implementing Regulation (EC) No 29/2009 "laying down requirements on data link services for the Single European Sky" (amended by Commission implementing Regulations (EU) 2015/310 also repealing Implementing Regulation (EU) No 441/2014). This technology is of crucial importance for a number of other technology-based improvements, including in the Pilot Common Project. The ELSA Project, driven by the SJU upon a European Commission mandate in 2015, gathered under a single forum a team composed of some 30 different organisations or companies (ANSPs / Airspace users / Boeing / Airbus / SITA – "*Société Internationale de Télécommunications Aéronautiques*" / ARINC - "*Aeronautical Radio, Incorporated*"...) to work together on the issue and jointly put forward conclusions and remedial actions. Two phases of investigations, measurements and simulations comprised of more than 400 revenue and measurement flights, analysis of 3 million air/ground exchanges, 700 hours of simulation representing 350,000 flight hours, and stress testing of common avionics configurations requiring about 50 days of cumulated live sessions were conducted. Together with several workgroup sessions, and special investigations into possible protocol optimisations, multi-frequency deployment options and technical details for multi-frequency network operation, they provided a wealth of observations and findings. This allowed for the drafting of concrete recommendations for improving the performance and robustness of the data link deployment, based on the current regulation and implementation rule, and also for the next phases of data link deployment. As a result of this difficult and complex, but collective work, the ELSA study was delivered in July 2016. Its recommendations were unanimously supported and actions are now being undertaken to implement them.

2. Surveillance infrastructure evolution: SESAR input to the Surveillance Performance and Interoperability - SPI - implementing Regulation update:

In 2014, the European Commission had mandated the SJU to outline a strategic approach for the Surveillance infrastructure evolution in view of the update of the SPI implementing Regulation. This Regulation, adopted in 2011, had triggered a number of comments, both concerning the approach followed and the deadlines imposed, in particular on airborne equipage. The SJU's direct access to a wide community of stakeholders and institutions was able, through its expertise and the organisation of well-attended workshops, to achieve widespread support on a two-step approach to the review of the implementing Regulation. The first step was to delay the date for the airborne equipage and this was achieved through implementing Regulation (EU) No 1028/2014 of 26 September 2014. The second step, which is ongoing, was supported by a document "SESAR input to the SPI IR regulatory update" (February 2015), consisting in the extensive review of the existing rule and the identification of areas of improvement. This input has been welcomed by the aviation community, which had been involved in the study and consulted on its outcome. It is now steered by the EASA and a specific Single Sky Committee meeting is planned on the issue.

These two examples highlight the ability of the SESAR Project and the SJU to federate energies and facilitate consensus to achieve the concrete deployment of technology, even in the cases were it was developed before SESAR was created.

### IX.3.1.7 The involvement of Regulatory Authorities

The SJU has concluded Memorandums of Understanding (MoU) with 16 Authorities and Letters of Agreement (LoA) with EASA and EUROCONTROL. In total, the Authorities participated in 32 validation exercises in three years and, together with EASA, submitted 1736 Regulatory Recommendations on different SJU deliverables.

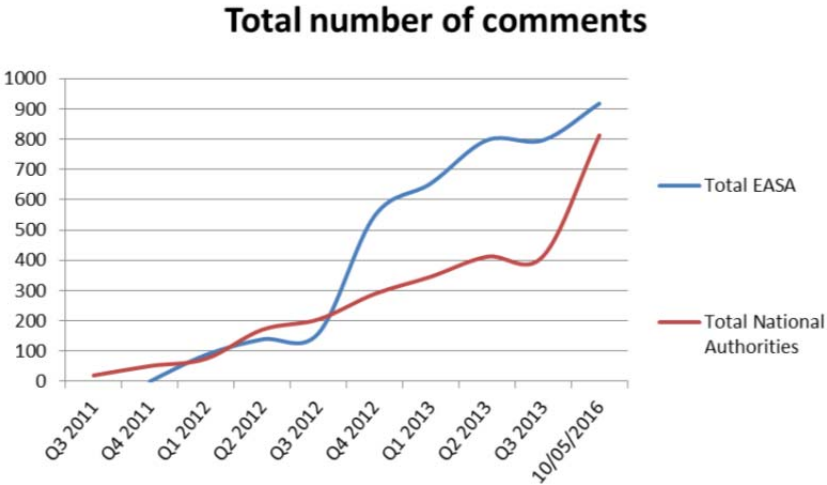As can be seen below, the national authorities and EASA involvement in SESAR evolved significantly since 2011:



**Total number of comments**

**Figure 22: The involvement of EASA and NSAs in SESAR**

In this way, R&I has been brought closer to the regulatory and rulemaking process, generating further confidence and buy-in from the regulatory authorities.

### IX.3.1.8 The involvement of military to secure an optimal civil-military cooperation

Whilst the Single European Sky initiative only applies to General Air Traffic (GAT) and not Operational Air Traffic (OAT), it is of crucial importance to secure good cooperation with, and involvement of, the military, which is a:

- Governmental Regulator
- Service Provider ATS/ATM
- Military Aircraft Operator
- Airspace User
- National Air Defence Organisation
- Military Certification Agency.

The military could be referred to as "one of the biggest airlines in Europe" as it can present the following features:

- 150 main military airfields
- 3300 combat aircraft
- 1000 transport type aircraft
- 5000 helicopters and light aircraft
- 1.6% of GAT flights: 160000* flights in 2013
- OAT (IFR+VFR) flights

*'The implications of Single European Sky (SES) and its technological pillar, SESAR, are considerable for the military. Our Member States have therefore entrusted the EDA to connect the military with each other as well as the European Institutions; to develop ways to engage Europe's military in the SES initiative; and to assist our Member States in accessing EU funding for technological initiatives from the SESAR programme. The constructive relationships with the SJU and the SESAR Deployment Manager are of utmost importance to achieve our mission.'*

For these reasons the military have been associated at all levels (Master Planning Group and Campaign Steering Committee) and at all steps (drafting, consultation, review) of the 2015 European ATM Master Plan campaign. Bilateral meetings took place as necessary between the SJU and military throughout the campaign. The specific military performance requirements are explicitly identified in the last version of the Master Plan and a specific Executive Summary has been prepared. Through their attendance as part of the national delegations in the Single Sky Committee meetings and as

Member of the SJU Board, the military can express their concerns and requirements up until the final approval of the Master Plan.

For the execution of the Master Plan, the European Defence Agency – EDA - is the partner institution with the SJU to address all military needs and requirements.

Furthermore, EUROCONTROL provides at project level civil-military coordination and its military expertise:

Innovative concepts and technical solutions have been proposed, validated and integrated in the Master Plan to accommodate military operational requirements and to ensure a high level of safety and interoperability.

As part of the concept of "Mission Trajectory" Airspace modules can be adjusted in real time to military needs. This information is shared with the network and military IFR trajectories can be shared and accommodated by the European ATM infrastructure.

In support of this concept and in partnership with the Defence industry, SESAR 1 has developed a wide range of technical improvements with minimum impact on existing avionics and ground systems used for airspace management, mission planning and flight management. These interoperability solutions will further mature in SESAR 2020 projects with special focus on secure exchanges of ATM information and higher integration of military flights in the Network.

The Military Engagement Plan for SESAR (MEPS) provides a EUROCONTROL framework for the participation of military experts in SESAR. The priority is to support the description of the concept of operation and to ensure that civil-military interoperability requirements are met. Currently, over 90 experts from Belgium, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and Finland have been directly involved in SESAR 1 projects.

These arrangements will be extended under SESAR 2020, securing a permanent and in-depth military involvement in all SESAR work.

### IX.3.1.9 Driving EU leadership at global level

While the main focus has been on Europe's skies, since its outset the SESAR programme for R&I has been committed to global harmonisation and interoperability, recognising these as prerequisites for a smooth and seamless transition towards a global ATM system in line with the ICAO Global Air Navigation Plan (GANP). The Programme has provided major input to, and has been a major source of inspiration for, the development of ICAO's GANP and Aviation System Block Upgrade (ASBU) Modules.

The Programme also works closely with industry standardisation bodies to advance common industry standards and procedures. This has been achieved through long-established and close cooperation with other ATM modernisation programmes in the world, notably the FAA's NextGen Programme. In 2011, the USA and EU signed a Memorandum of Cooperation (MOC) on Civil Aviation Research and Development, establishing the framework for

*'From the very beginning we understood the importance of harmonizing NextGen and SESAR and recognized the value in using these programs to lead the world in global modernization.*

*We have come together to solve the key challenges necessary to make unprecedented advances in aviation efficiency, capacity, and safety. Of particular note is our collaboration on Datacom, SWIM, information exchange models, 4D operations, and emissions reduction trials.*

*Our accomplishments will endure for years to come.'*

**Jim Eck**, Assistant Administrator for NextGen, Federal Aviation Administration (FAA)

cooperation to ensure global interoperability between NextGen and the SESAR programme, taking into account the interests and needs of all airspace users. Together, work is underway on a wide range of topics, including concepts and architecture, ICAO and standards coordination, information management, trajectory based operations, avionics and CNS, as well as specific collaborative projects such as demonstrations and flight trials.

This international cooperation aiming at global harmonisation and interoperability now allows Europe to speak in a single voice and therefore be heard at a worldwide level. It also maintains Europe on the leading side of technological innovation, literally "setting the standards" and thus supporting the European industry.



**Figure 23: Towards global harmonisation and interoperability, making Europe's voice heard**

Furthermore, the SESAR programme fully supports all aspects of the European Commission's Aviation Strategy for Europe[71], which aims for an ambitious EU external aviation policy, tackling limits to growth both in the air and on the ground, maintaining high EU standards, and sustaining innovation, investments and digital technologies.

Notably, through its external relations and communications activities, the SJU continuously strengthens partnerships with both public and private stakeholders in policy and strategic technical areas of mutual interest, seeking to coordinate and exchange experience and knowledge and to formalise such relationships through the signature of appropriate Cooperation instruments.

SESAR also works together with a large number of different stakeholders to strengthen relationships at global level and secure access to the global market for the European Industries. Cooperation with Next Gen / FAA, Mexico, Brazil, Japan, China, Australia, Singapore and regional cooperation with Africa, Gulf States has showed that this is crucial for an effective mutual development and for global interoperability.

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[71] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2015:598:FIN
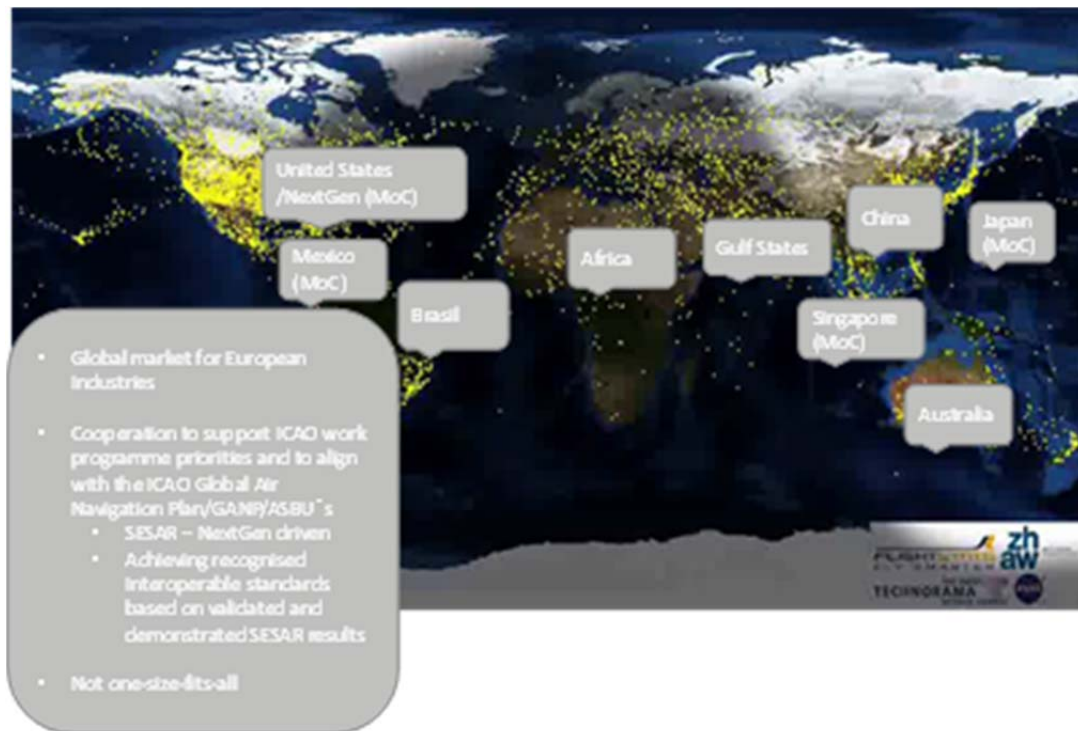
**Figure 24: Promoting the European aviation industry at global level**

This permanent effort to support the European industry at global level shows impressive results, allowing a strong presence and weight of European industry on the global aviation scene.

### IX.3.1.10 How SJU's PPP is perceived by the member

In 2014, a communication perception exercise was carried out to better understand how Members perceive the added value of SESAR's PPP. The results were very encouraging and can be synthesised as follows:

1. The rationale for SESAR

    o Modernise ATM: The underlying purpose of SESAR has been and will be to continue ensuring the modernisation of ATM. Although air traffic growth has abated since 2007/8, the need for modernisation of ATM still exists in order to ensure better performance efficiency and global interoperability and harmonisation. The difficulties faced by airlines make it even more important to secure substantial performance gains.

    o Overcome fragmentation: Federating European R&I efforts, implementing a truly collaborative approach with the involvement of a wide range of stakeholders has been a major part of SESAR's success.

    o Move towards deployment: Customers and stakeholders demand both an increased rate of delivery and a greater focus on delivering deployable results that once in place can really make the difference in terms of benefits. The Pilot Common Project

> *'The philosophy of the Commission's intervention, from the start, was to say to industry, "We will create the right environment, we will give the means we have and we will guide you, but in the end it will be up to you. After all, it is your business, your investments and you are going to be empowered to run the ATM system".'*
>
> **Daniel Calleja Crespo**, Former Director for Air Transport, former Head of Cabinet of Commissioner de Palacio and former Chairman of the SJU Administrative Board.

shows the value of the expertise provided through the SJU, however further value could be added by focusing on the gap between R&I and deployment, and making sure follow-through is considered to ensure the relevance of SESAR Solutions.

o Spur innovation: SESAR is not about deployment alone, it is also about looking beyond deployment in order to trigger long-term change and benefits.

2. The value of SESAR and the SESAR partnership

o Innovative: The SESAR R&I Programme has proven itself to be a test bed for the development of future-proofed solutions and a mechanism for forming links with other key players involved in ATM technology.

o Cost-effective: Sharing research and innovation costs through the public-private partnership is the only viable approach to sourcing the huge investments required for large-scale aviation projects.

o Collaborative: SESAR / SJU provides a platform allowing all relevant ATM stakeholders to coalesce and is a collaborative body to ensure projects are done at the right price.

o Risk-averse: Being part of a European project means that the choices being made in terms of technologies and standards are going to be European choices, thereby reducing technological risk and uncertainty for a company. As a unique stakeholder platform for the development and validation of different products, SESAR also reduces technical risks in terms of their global interoperability.

o Best-in-class: ATM systems and tools developed jointly by a number of service providers are often superior to those developed by a single organisation in-house. No matter how far advanced and innovative any one company might feel about its own activity, ideas from others can lead to better results.

o Policy-driven: SESAR remains the technological pillar of the Single European Sky (SES) and is therefore driven by a clear policy framework. Close association with the SES adds value to the SESAR brand. Disassociation from the SES would mean that SESAR becomes just another European research and innovation project.

### IX.3.2 Where did the money go?

#### IX.3.2.1 What does SESAR represent

Since its establishment in 2007, the SESAR Joint Undertaking (SJU) has conducted more than 350 validations, mobilising more than 3000 experts in the period 2008-2014[72]. This allowed for the development of a network of skilled experts across the Member States' ATM industry.

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[72] The equivalent to 1.800 full-time jobs as an average, directly employed in SESAR work, and up to the equivalent of 2.500 full-time jobs for the additional efforts carried out during validation exercises or flight demonstrations

**Figure 25: What SESAR represents**

Such collaboration has led to the delivery of more than 90 industry prototypes, thereby setting a new standard for the future evolution of systems both on the ground as well as in the air. The SJU has also carried out more than 30 000 individual flight trials demonstrating the readiness of SESAR Solutions for wider scale deployment.

The current execution of SESAR development benefits not only to the members of SESAR and the users of air transport, but also to a big amount of other entities, more than 100, which work in SESAR as affiliates, associates, subcontractors or under other arrangements. Among those, can be mentioned at least 10 universities from 5 EU Member States, and a significant number of Small-Medium size Enterprises.

### IX.3.2.2 The SESAR 1 Budget

Detailed figures appear in annex C.

### IX.3.2.2.1     The apportioning of the Budget

The original budget envelope for the SESAR 1 Development was planned to be of 2.1 Billion EUR, split equally between the three main contributors EU (700 Million EUR), EUROCONTROL (700 Million EUR) and the private Members (700 Million EUR).

However the Membership agreements concluded with all Members refined this initial envelope and fixed the total overall budget at 1.9 Billion EUR (latest contractual values in place since 1 January 2014). The split was: EU (700 Million EUR, 36%), EUROCONTROL (670 Million EUR, 34%), private Members (584 Million EUR, 30%).

Whilst the EU contributed only in cash to the SJU, EUROCONTROL and Members mainly contributed in-kind. The cash from the EU was used to co-finance the private Members' cost incurred for delivering the results agreed. The remaining value of these costs after deducting the EU Co-Financing will be the "net" contribution of 584 Million EUR of the private Members at the end of the programme.

The 1.9 Billion EUR Budget was allocated as follows: 1.6 Billion EUR on the "core programme" (i.e. the work-packages managed by the SJU Members), 0.2 Billion EUR on "Other studies and programme support activities" (e.g. Exploratory Research, Demonstration activities, Industrial and Programme support, etc.), and 0.1 Billion EUR on the Running costs of the SJU itself (Staff & Administration).

The "Core programme" budget itself can be split into the 4 Key Features of the Master Plan:

- Advanced air traffic services 430 Million EUR (28%),
- Enabling aviation Infrastructure 504 Million EUR (32%),
- High-performing airport operations 367 Million EUR (24%) and
- Optimised ATM network services 258 Million EUR (17%).

Part of the "Core programme" budget (including parts of WP11) can also be split over Operational Focus Areas (OFAs). Their total budget of 1.1 Billion EUR is allocated over more than 30 OFAs.

### IX.3.2.2.2 The actual figures (Cumulative until 31 December 2015)

By the end of 2015, 1.4 of the 1.9 Billion EUR was already implemented (74%), with one full year of the Programme still outstanding (details in 0).

An overall implementation rate of 87% is expected by the end of the Programme.

Running Costs of the SJU shall stay far lower than budgeted (current estimate: below 70%).

The implementation of the "core programme" was of 80% at the end of 2015 and we foresee to reach 89% at the Programme closure.

For each of the 4 Key Features the actual implementation end of 2015 was as follows: Advanced air traffic services 334 Million EUR (78%), Enabling aviation Infrastructure 414 Million EUR (82%), High-performing airport operations 300 Million EUR (82%) and Optimised ATM network services 193 Million EUR (75%), as shown in table Annex 3 of Annex C.

The overall OFAs implementation rate at the end of 2015 was of 79%.

### IX.3.2.3 SESAR 1's return on investment

The European Commission has consistently stated that technology deployment should be performance-driven[73], and in an economic crisis context this is supported by the entire stakeholder community. Performance is therefore at the heart of the SESAR endeavour. It is logical then that the programme has an integrated performance framework and management process through which SESAR Solutions must pass. This approach means that at the very outset, SESAR Solutions are designed to respond to a range of performance expectations and validation targets (Safety, cost-efficiency, environment, capacity, operational efficiency and security). The indicators and metrics are either aligned, or at least "cross-readable", with the SES performance scheme indicators, as explained in paragraph 0. The framework and process also allow for the traceability of performance throughout the development of the solutions until their delivery. Regular performance assessments are made providing the detailed calculations, assumptions and gap analysis for Solutions.

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[73] See inter alia the Commission Consultation paper of Establishment of 2 September 2011 on "governance and incentive mechanisms for the deployment of SESAR, the Single European Sky's technological pillar": http://ec.europa.eu/transport/sites/transport/files/modes/air/sesar/doc/2011_09_13_consultation_paper.pdf

EUROPEAN UNION    EUROCONTROL

### IX.3.2.3.1 The overall benefits enabled by SESAR

Due to the different duration of maturity evolution cycle for different SESAR Solutions, there are a number of them which are ready for industrialisation at the end of SESAR 1 programme, or even already industrialised, and another set for which additional R&I work is planned to be extended into the SESAR 2020 Programme before they can reach industrialisation maturity. This is explained in more detail in paragraph 0.

The following figure depicts in a synthetic way, the overall performance that is expected to be delivered by SESAR 1 and the SESAR baseline (i.e. technology improvements coming from pre-SESAR initiatives), provided that deployment is achieved in an optimal and timely manner:
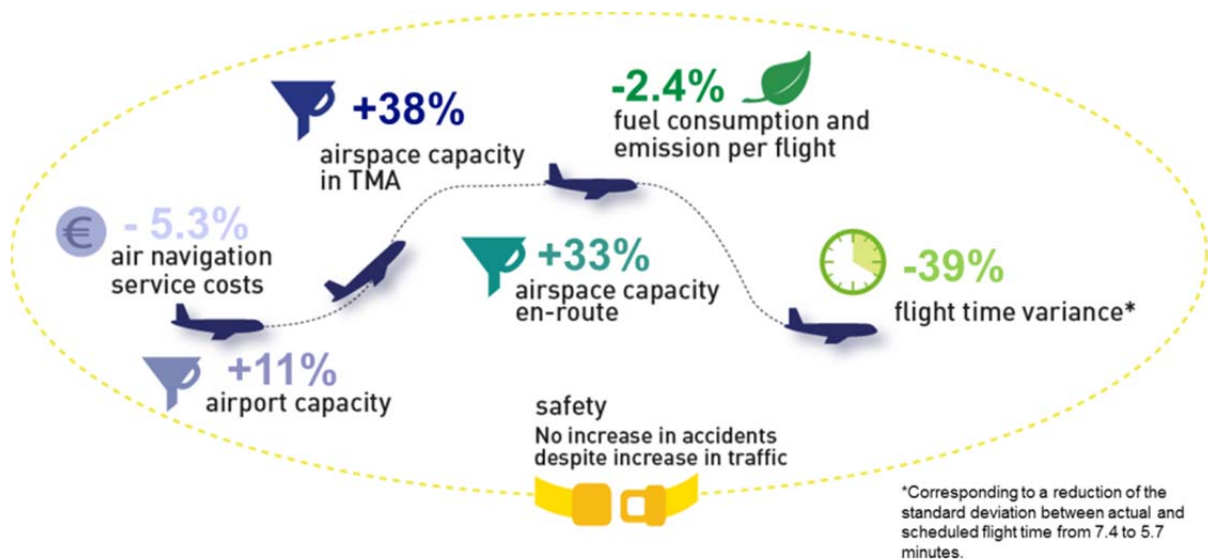


**Figure 26: Performance expected from all solutions started under SESAR 1 + Baseline**

Overall, the value for money of SESAR 1 is very positive. The benefits generated at ECAC level if and when all performing SESAR 1 Solutions are deployed are expected to be of 1.7 Billion EUR per year (at 2012 traffic levels), versus a total, "one-shot" expenditure of 1 Billion EUR in R&I. In other terms the annual benefits generated by the deployment of SESAR 1 Solutions are expected to be 70% higher than all 2009-2014 budget spent on the corresponding R&I. It has been estimated that, for every EUR invested in SESAR R&I, there is an expected return on investment of 6 EUR.

### IX.3.2.3.2 An overview at key performance indicator level

Figure 27 below breaks down the SESAR 1 performance expectations, differentiating and comparing per key performance indicators the gains expected from:

- First column: the result of the validation activities in SESAR 1, broken down between Deployment Baseline (DB), performance expected from PCP, and performance expected from the other relevant SESAR 1 Solutions,
- second column: the expectations from the PCP CBA,
- third column: the strategic objectives from the MP edition 2012 (corresponding to the Deployment baseline plus expectations from what was described as "Step 1" of SESAR),
- fourth column: the 2035+ ambitions from the MP Edition 2015,

all this adjusted to the 2005 traffic levels to allow comparison.

Founding Members

**Figure 27: The performance expectations by Key Performance Indicators[74]**

To take an example, looking at the first indicator "reduction of fuel burn per flight", the figure shows that the strategic objectives of the Master Plan 2012 (2.4%) correspond well to the sum of the SESAR 1 validation activities (2.36%). The PCP CBA result (2.10%) is slightly superior to the expectation from the SESAR 1 validation activities (1.86%). The overall ambition of the implementation of the entire SESAR Programme up until 2035+ (8%) is largely superior to the Baseline and Step 1 expectations (2.4%).

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[74] 1 - Considering additional flights at congested airports equivalent to the additional constrained runway throughput.

2- Assuming an equivalent ambition to Network throughput.

3- Considering Network throughput equivalent to additional constrained airspaces throughput.

4- Only limited to ATCO productivity, which accounts for 30% of the average EU ANSP cost base.

5- Including variability reduction for PCP CBA, while no strategic objective was given in the MP 2012.

6- MP 2012 targets refer only to Deployment Baseline (DB) and Step 1

7- MP 2015 ambition levels relate to the whole roll-out of the SESAR vision independently of steps

The reduction of fuel burn per flight relates to the Environment key performance area. The Capacity key performance area is expressed through Runway, TMA and en-route additional peak throughput at already constrained locations. Gate-to-gate direct ANS Cost relates to the Cost-efficiency key performance area. Predictability is an additional key performance area, whose indicator (flight time variance) is tightly linked to the Operational efficiency key performance area. In this way SESAR benefits can be translated into SES performance scheme metrics and therefore measurable in terms of SES performance improvements.

Other key performance areas such as Safety, Punctuality, Flexibility and Civil-Military Cooperation and Coordination have been assessed but not monetised. Safety is, as matters of principle, not monetised, and for the others their underlying methodologies for monetisation are not yet mature and the risk of double-counting of benefits on delays is not yet fully avoided. For resilience a first attempt has been made to monetise the benefit of LVP using GBAS, through the monetisation of avoided cancellations.

Furthermore, a number of key SESAR Solutions have not yet been included. For example User-Driven Prioritisation Process has been recently assessed to bring hundreds of Euro Millions per year in terms of savings to Airspace users' operating costs[75], but this has not yet been captured in the analysis of SESAR 1 performance gains due to the different granularity of the results.

For these reasons, the performance benefits highlighted in this paragraph should be considered as conservative and substantially underestimated.

### IX.3.2.3.3    Drilling down at a more detailed level

The potential performance impact that validated SESAR Solutions can have once they have been deployed can be assessed and compared with the actual expenditure[76] incurred to finance the related R&I projects. In the table below, the Solutions have been clustered by thematic "Operational Focus Areas":

| Operational Focus Area | R&D investment in SESAR 1 (EUR) | Total potential yearly benefits (EUR) |
|---|---|---|
| LVPs using GBAS | 51.288.749 | 10.389.542 |
| Pilot enhanced vision | 10.097.791 | Safety |
| Airport safety nets | 33.501.191 | Safety |
| Enhanced Runway Throughput | 58.229.089 | 95.336.921 |
| Optimised 2D/3D Routes | 18.063.394 | 416.409.915 |
| Free Routing | 61.412.494 | 184.696.853 |
| Business and Mission Trajectory | 32.254.709 | 7.469.612 |
| ASAS Spacing | 26.444.041 | 48.086.797 |
| ATSA-ITP | 7.876.950 | Not Assessed |
| ASEP | 14.857.108 | Not Assessed |
| Ground Based Separation Provision in En Route | 32.688.151 | 210.031.057 |

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[75] See SESAR 1 Business Case

[76] Total actual expenditure 2008-2015 including the amount paid by the SJU and the costs by the members

| | | |
|---|---|---|
| Ground Based Separation Provision in the TMA | 28.331.893 | 170.308.720 |
| Enhanced Ground Based Safety Nets | 8.154.975 | Safety |
| Enhanced ACAS Operations | 9.787.250 | Safety |
| Integrated Arrival/Departure Management at Airports | 21.563.069 | 30.155.505 |
| Enhanced Arrival & Departure Management in TMA and En Route | 62.074.182 | 51.472.347 |
| Integrated Surface Management | 50.691.364 | 149.139.082 |
| Airport Operations Management | 41.938.689 | 153.098.453 |
| Airspace Management and AFUA | 8.591.148 | 49.728.760 |
| Dynamic Airspace Configurations | 8.980.336 | 57.617.565 |
| Enhanced ATFCM processes | 28.633.262 | 129.146.192 |
| UDPP | 13.565.056 | Flexibility of AU Ops |
| Network Operations Planning | 16.701.340 | Predictability |
| CWP Airport | 27.138.732 | Technology enabler |
| CWP En Route and TMA | 10.178.098 | Technology enabler |
| Remote Tower | 20.799.502 | 21.879.719 |
| Communication | 46.473.646 | Technology enabler |
| Navigation | 13.554.334 | Technology enabler |
| Surveillance | 16.915.362 | Technology enabler |
| SWIM | 53.849.627 | Technology enabler |
| AIM/MET | 15.831.098 | Technology enabler |
| Trajectory Management Framework and System Interoperability with air and ground data sharing | 55.765.465 | Technology enabler |
| **Total** | **EUR 906.232.094** | **EUR 1.784.967.041** |

**Table 32: Budget and potential benefits stemming from SESAR 1 once deployed**

The areas with the highest benefit / cost ratio are Optimised 2D/3D routes (bringing higher capacity thanks to Advanced RNP Operations in en-route and Point Merge in TMA, fuel efficiency thanks to strategic de-confliction of traffic and cost efficiency-thanks to higher ANS productivity) and Ground Based Separation Provision (bringing higher ANS productivity and capacity thanks to Sector Team Operations and to the advanced tools to reduce controller workload). Free Routing, where implemented, is already bringing substantial benefits especially in fuel-efficiency and predictability.

Other areas with a very high benefit / cost ratio are Integrated Surface Management, Airport Operations Management, Airspace Management and Advanced Flexible Use of Airspace (A-FUA), Dynamic Airspace Configurations, Enhanced ATFCM processes. In addition, the areas of ASAS Spacing, Enhanced Runway throughput and of Integrated Arrival/Departure Management at Airports are foreseen to be beneficial, even if the benefits stemming from increased resilience of airport capacity to bad weather have not been fully accounted in the analysis.

Other areas have as main focus the guarantee of maximal levels of Safety under all conditions and such benefits have not been monetised (Pilot enhanced vision, Airport safety nets, Enhanced Ground Based Safety Nets, Enhanced ACAS Operations, etc.). Others are considered as technological enablers to the realisation of the benefits into other areas and therefore not considered beneficial per-se.

On the other hand, the figure shows that the area of Enhanced Arrival & Departure Management in TMA and en-route, which is beneficial for TMA capacity requires more R&I work before its positive potential can be fully assessed. Another area for further work is the LVP using GBAS, providing benefits under very specific conditions and too intimately linked with other applications (e.g. CAT I operations using GBAS) to be assessed alone. Business and Mission Trajectory is on the other hand

an area for which few validation results are available and the confidence of the current assessment is low.

### IX.3.2.3.4 The Pilot Common Project, first materialisation of coordinated deployment of SESAR 1 outcome shows high leverage achieved through SESAR PPP approach

The Pilot Common Project[77], developed by the SJU upon European Commission mandate, is the first concrete materialisation of the Commission's Deployment strategy and the first experience of coordinated deployment of a coherent set of technology packages developed under the SESAR 1 Programme and baseline. The technology packages contained in the PCP (grouped into 6 "ATM Functionalities" and implementing 23 of the 61 mature SESAR 1 Solutions) are expected to be deployed between 2015 and 2024, and to deliver a total of about 12.1 Billion EUR worth of performance gains for some 3.8 Billion EUR of investments[78], as follows:

- Fuel cost savings: 8.0 Billion EUR
- ANS productivity gains (generating lower user charges): 2.8 Billion EUR
- $CO_2$ savings: 0.8 Billion EUR
- Delay cost savings: 0.6 Billion EUR

To deliver the SESAR Solutions contained in the Pilot Common Project approximately 260 EUR Million of public money were invested in R&I (or one third of the overall R&I spent in SESAR 1). When discounting benefits expected from the roll out of the PCP for the period 2014-2030, the net present value of the PCP seen as a holistic investment from R&D to deployment is significantly positive for the European community with 1,7 billion EUR of net benefits.
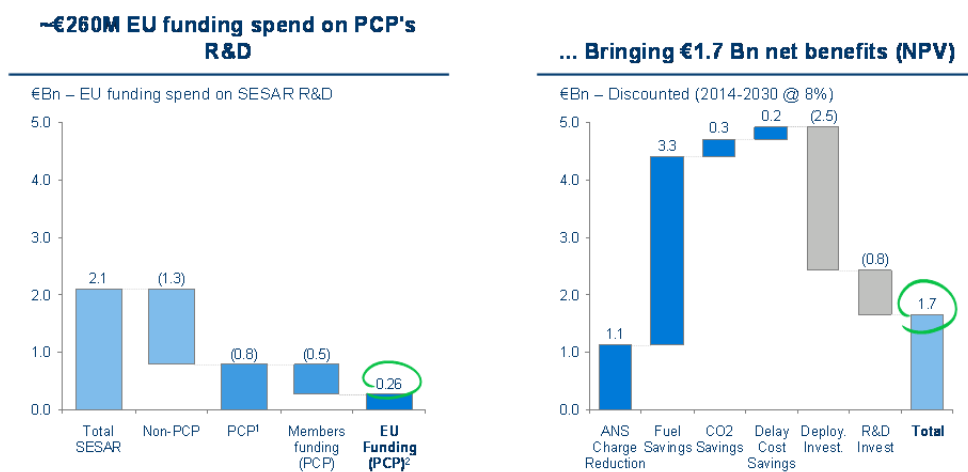


**Figure 28: The PCP Business Case**

Through the strong link between development and deployment activities, SESAR – also looking at other EU Public Private Partnership initiatives – is a pioneer in identifying costs and benefits thanks to its holistic ATM Master Plan. The example of the PCP, now moving towards a successful

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[77] Commission Regulation (EU) No 716/2014 of 27 June 2014

[78] SJU Proposal on the content of a Pilot Common Project, Edition 1.0, 06/05/2013. Figures are undiscounted.

deployment, shows that the strategic alignment of private and public research objectives has facilitated an increased industrial participation in the European R&I efforts, providing more effective outputs leveraging EU funding instruments.

For the European Commission, which has been investing heavily in the SESAR Public Private Partnership to enable a long-term, strategic approach to research and innovation and reduce uncertainties by allowing for long-term commitments, the example of the PCP shows that, for every 1 EUR invested in SESAR brings 6 EUR in return for Europe.

### IX.3.3 Did we live up to expectations and are we fit for the challenges ahead?

#### IX.3.3.1 SESAR is performing, agile and adaptable

The SESAR project is complex, far-reaching, and associating a large number of stakeholders. Still, the PPP setup and SESAR governance structure allow the programme to remain performing, adaptable and even agile, so as to change orientation when needed, following the evolution of context and priorities. It can also catch new challenges as soon as they arise: Two new important issues have arisen in the recent future: Drones / RPAS and cybersecurity, leading the SJU Board to instruct the SJU to include both these issues in the 2015 Master Plan update campaign.

#### IX.3.3.1.1 Performance

In the performance domain, until the 2012 Master Plan Edition and the launch in 2012 of the SES performance scheme, focus was on capacity and delay issues. The financial crisis affecting the European economy and in particular aircraft operators, as well as lower traffic forecasts drove a change of priorities towards cost-efficiency issues and environment issues to also follow societal requirements, safety remaining paramount. The prioritisation of R&I and the indicators to measure technology performance were adapted accordingly. Furthermore the SESAR performance indicators, which had been set before the SES performance scheme, were gradually reviewed to converge towards "cross-readability" with the SES performance scheme so as to better measure technology contribution to reaching SES performance goals and targets. This is explained in more detail in Paragraph 0.

It can be recalled that, at the time of its closure, SESAR 1 will have actually delivered 61 Solutions, ready for pre-industrialisation and delivering substantial performance benefits More SESAR 1 Solutions are still under development and will provide additional performance in the coming years. This is detailed in Paragraph 0 and Section 0. It should be recalled that, for every EUR invested in SESAR R&I, there is an expected return on investment of 6 EUR.

#### IX.3.3.1.2 Agility

Comparable to the agility applied at the ATM Master Plan level, during SESAR 1, the SESAR JU has conducted two major reallocation exercises with its Members, which has enabled to reassign priorities taking into account the first conclusions of R&I activities, and to introduce new topics in the work programme that had not been included initially.

During these reallocation exercises, conducted in 2011 and 2013, the budget allocation and the specific contribution of each partner was open for revision, and the scope and objectives of each specific project could be realigned with the programme priorities.

Furthermore, the work programme itself was revised, with for instance the introduction of Demonstration activities concept and the inclusion of RPAS, respectively in 2012 and 2013, which stresses the ability of the SESAR JU to integrate new topics and let the R&I model evolve.

### IX.3.3.1.3    RPAS / Drones

SESAR is already leading R&I in the field of RPAS / drone (for facility, hereafter "the drones") ATM integration in Europe. It has started addressing the main challenges of making sure that the drones are safely integrated into the airspace and ATM environment and align with the need to operate safely in a mixed unmanned / manned aircraft airspace and ATM environment without incidents or accidents.  At the same time, appropriate regulatory and standardisation measures need to be put in place.

In 2012, experts in the field were called upon by the European Commission to develop a European roadmap for the integration of unmanned aircraft (drones) which was officially launched in June 2013. This roadmap identified a step-by-step approach for the safe integration of drones into the non-segregated ATM environment in Europe as of 2016.

The SESAR programme is playing an important role in this roadmap, to further research and develop what needs to be done to ensure the safe and seamless integration of drones with manned aircraft operations.

The SJU first launched a series of SESAR demonstration activities to put the drones' integration to the test. Operators, manufacturers, ANSPs and regulatory authorities worked together in real operational environments to identify any operational, technological and regulatory gaps. The insights and results from these demonstrations have helped shape the SJU's R&I programme, collected in what is known as the SESAR RPAS Definition Phase. In a nutshell, the programme has seven areas where R&D should be carried out:

1. Detect and avoid in the same or improved way that manned aircraft;
2. Digital data communication capabilities for both the control and command  of the drone;
3. Airspace access and airport operations that allow drones to seamlessly integrate with manned aircraft in all types of airspace classes and airports;
4. Contingency measures to handle all failure scenarios of the drones;
5. Human factors i.e. drones interaction with the relevant human operators in the ATM system;
6. Security and in particular cyber-resilience;
7. The coordination of demonstrations and validations activities to maintain a good understanding of what is further needed for drone development and integration.

In addition, SESAR seeks to leverage developments from other industry sectors with similar infrastructures, such as telecommunications, for the purpose of ATM R&I. Knowing what is on the horizon allows being prepared for technology transfer opportunities and ready to adapt SESAR R&I activities when needed. For that reason, the SJU investigated in 2016 current and future drones' market trends with the aim to develop a 2050 market outlook for drones and its economic impact. The "SESAR European Drones Outlook Study" has been made public on 23 November 2016.

Depending on the progress of such activities, a partial update of the Master Plan in 2017 is also considered so as to reflect and integrate the importance of drones in the SESAR Programme and bring them to a further level of accuracy and maturity in SESAR 2020.

### IX.3.3.1.4    Cyber-security

To support the future European ATM system, the SJU commissioned a study setting out the elements needed to introduce a holistic approach to cyber-security and to develop a comprehensive response to cyber threats, which includes a roadmap for increasing the maturity of cybersecurity and cyber-resilience processes within the SJU's research and innovation (R&I) in preparation for SESAR 2020. Its outputs defined a holistic approach to cyber-security and how to develop a comprehensive response

to cyber threats, using System Wide Information Management (SWIM) as an illustration of how cyber-risk is changing in air traffic management. The study completed in May 2015 and a public summary is available.

In order to develop concrete recommendations for the SJU, the study had to consider the context in which the SJU works and, specifically, the likely shape of a Europe's response, including both regulatory and service provision functions. To this effect a Study's Dissemination Workshop was held on 12 April 2016, allowing communicating to interested Commission services and agencies the outcomes of the study to allow concerned parties to connect this to their respective agendas and draw conclusions. Representatives from DG-MOVE, DG-HOME, DG-CONNECT, EASA, ENISA and EDA were present.

The outcome of the study and the workshop are the following:

1. The SJU has a key upfront role to play in addressing cyber-risks within ATM, primarily in delivering 'securable' solutions that, once industrialised by the supply industry and deployed by operational stakeholders, provide the security and resilience needed.
2. Cyber-threats, vulnerabilities and risks are very real and complacency must be avoided; risks through the supply chain are a particular concern, as attacks may not be on end systems but on infrastructure components (for power, ventilation, etc.) on which end systems rely. An end-to-end approach is vital.

Cybersecurity is a new priority for SESAR (as exemplified by the 2015 European ATM Master Plan), and this will ripple down and through SESAR 2020 activities and solutions. SESAR (and the SJU) are not on their own since securing ATM against new threats requires a coordinated response from all actors: service providers, regulators, national authorities and of course the EU and EASA.

***IX.3.3.2 Evolving and delivering: the Master Plan evolution shows the agility of the Programme***



**Figure 29: The three levels of the Master Plan**

The broad range of R&I projects and the fact that SESAR is a living and evolving programme had to be documented and supported by a robust planning and change management process.

In order to keep track in the European ATM Master Plan of the progress of the development activities, a comprehensive data change management process was implemented in the early stages of the SESAR 1 programme. This allowed to steer and document the changes and to show to stakeholders and decision-makers the latest available information in a 6-monthly cycle resulting in so-called "Datasets", which, together with the architecture, constitute Level 2 "Planning view" of the Master Plan. The mission of the SJU is to steer, monitor and control this evolution and ensure continued coherence with Level 1, the "executive view". When relevant, the Datasets were synchronised with the publication of the different Editions of the Master Plan, thus ensuring perfect

match and synchronisation between all levels of this Master Plan. The last data change management process produced under SESAR 1 was materialised by the production of "Dataset 16" at the end of May 2016, allowing materialising at planning level the outcome of the Master Plan update campaign of 2015.

This planning and change management process involved representatives from projects from all areas of the programme. It provided an overview of the progress of the content of the SESAR 1 programme, as well as of the standardisation and regulatory needs and roadmaps. Furthermore, it evolved to reflect the focus on Essential Operational Changes and on the Pilot Common Project (PCP).

### IX.3.3.2.1    2011: Prioritising R&I and creating the concept of Essential Operational Changes

Figure 30 shows how the SESAR 1 programme endeavoured to prioritise its efforts and focused as early as 2011 on the identification of "Essential Operational Changes".
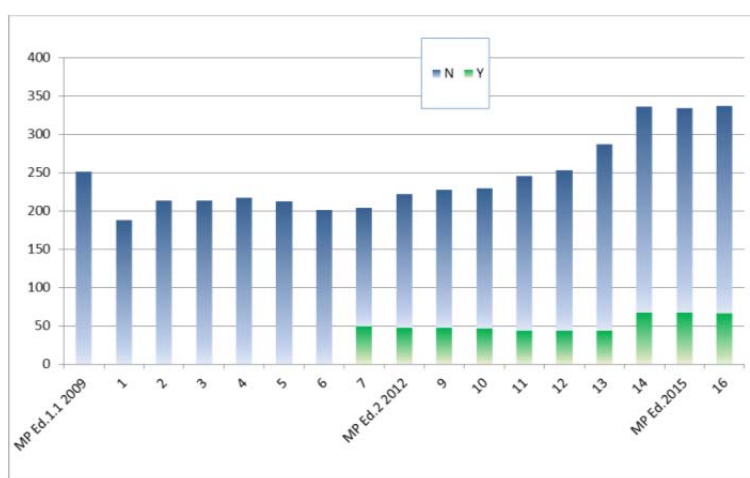


**Figure 30: Prioritisation and focus of the SESAR 1 programme**

In preparation of the Master Plan 2012, Dataset 7 was the first one to capture the concept of Essential Operational Changes that were published with the Master Plan. This classification defined the basis for the prioritisation of the next wave of deployment, and was incorporated in Implementing Regulation (EU) No 409/2013 on common projects, making the Master Plan and its Essential Operational Changes the sole source for setting up common projects[79].

### IX.3.3.2.2    2015: Introducing the Pilot Common Project (PCP) data and identifying new Essential Operational Changes

At the beginning of 2015 (with Dataset 14) and the start of the Master Plan Update Campaign the list of Essential Operational Changes was reviewed and published with the Master Plan Edition 2015.

As a result, the Essential Operational Changes are now of two kinds: Those that are integrated in the Pilot Common Project, and therefore in deployment phase, and a number of "new" Essential Operational Changes, identified as "in the pipeline for deployment", and therefore already

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[79] Implementing Regulation (EU) No 409/2013, Articles 2(7) and 4.1.

earmarking potential candidates for a future common project, subject of course that they comply with the three criteria of maturity, network performance and need for synchronised deployment. These Essential Operational Changes can be seen in Figure 9 of Edition 2015 of the Master Plan.

The Datasets also identify the prerequisites, enablers or facilitators of the PCP, in full coordination with the SESAR Deployment Manager, thus ensuring coherence within the SES geographical scope through alignment between the Master Plan and the Deployment Programme, but also broadening the implementation scope at ECAC level to ensure pan-European coherence (e.g. for an optimal deployment of SWIM or i4D).

Level 3 of the Master Plan, the "implementation Level", composed of an annual Plan and an annual report, is then in a position to set clear implementation objectives for the mature and performing technology, and also report on their implementation status.

In this way, the Master Plan has now achieved its mission to bridge the gap between R&I and deployment, as requested per implementing Regulation (EU) No 409/2013.

### IX.3.3.2.3    From R&I to Deployment: Maturing in the SESAR life-cycle

Figure 31 shows an overview of the maturity indicator per SESAR Release and Step as available in the Master Plan Level 2 Dataset. This Figure still reflects the now obsolete "Steps" approach of SESAR 1, which has been replaced by a more continuous evolution, reflected both in Edition 2015 of the Master Plan and the SESAR 2020 setup.
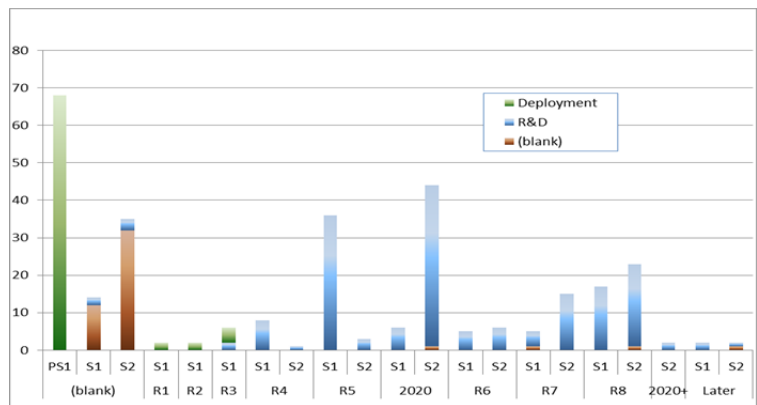


**Figure 31: Maturing in the SESAR 1 life cycle**

It nevertheless shows that the Operational Improvement Steps from Releases 1, 2 and 3, as well as the Pre Step 1 (i.e. the pre-SESAR technology) are now largely under deployment. Releases 4 and 5 will soon switch from R&I to industrialisation and deployment.

### IX.3.3.2.4    Conclusions

The SESAR 1 programme shows a steady evolution of the definition of Operational Improvements. Coming from the SESAR definition phase and Edition 1 of the European ATM Master Plan in 2009, the programme gained precision in defining the SESAR Solutions to be validated.

With the 2012 update campaign for the Master Plan Second Edition, focus was introduced on Essential Operational Changes, allowing the setting of priorities within the programme. The introduction of the Pilot Common Project (PCP) emanating from the 2012 Essential Operational Changes was then introduced and the Master Plan 2015 reflected its scope in line with the European Commission's Implementing Rule. Finally, the change management process allowed highlighting and

tracking the maturing process through which R&I outcome gradually becomes ready for industrialisation and deployment.

*IX.3.3.3 Lessons learned and new challenges: What shall we do better under SESAR 2020?*

### IX.3.3.3.1    Driving digitalisation of ATM

The Master Plan 2015 has been developed in parallel with the definition of SESAR 2020 content and the prioritisation of projects. It outlines the vision to achieve "high-performing aviation for Europe" by 2035, i.e. once R&I results delivered by the SESAR Project will have been actually implemented. It also shows that the contribution of the technological pillar of the SES can be very substantial to achieve the SES High level goals:



**Figure 32: The SESAR Project performance ambition (from 2015 Ed. Of the Master Plan)**

The vision builds on the notion of 'trajectory-based operations' and relies on the provision of air navigation services (ANS) in support of the execution of the business or mission trajectory — meaning that aircraft can fly their preferred trajectories without being constrained by airspace configurations. This vision is enabled by a progressive increase of the level of automation support, the implementation of virtualisation technologies as well as the use of standardised and interoperable systems:
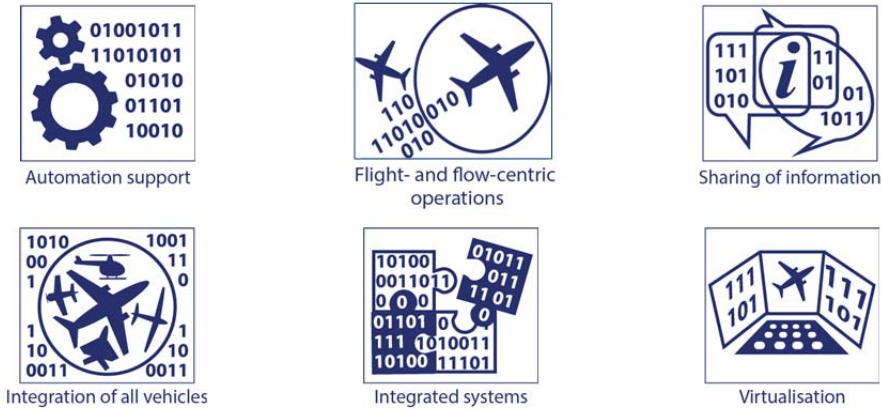


**Figure 33: What is needed to achieve the Vision (from 2015 Ed. of the Master Plan)**

The system infrastructure will gradually evolve with digitalisation technology, allowing air navigation service providers (ANSPs), irrespective of national borders, to plug in their operations where needed, supported by a range of information services. Airports will be fully integrated into the ATM network level, which will facilitate and optimise airspace user operations. Going beyond 2035 towards 2050, performance-based operations will be implemented across Europe, with multiple options envisaged, such as seamless coordination between ANSPs or full end-to-end ANS provided at network level.

Furthermore, it is widely recognised that to increase performance, ATM modernisation should look at the flight as a whole, within a flow and network context, rather than segmented portions of its trajectory, as is the case today. With this in mind, the vision will be realised across the entire ATM system, offering improvements at every stage of the flight.

> *The SESAR project is a key pillar of the Single European Sky project and arguably the one that will deliver the greatest benefits to airspace users. There is no doubt that the SESAR project will provide the next driver for air traffic management efficiency improvements. The role of ERA and the airspace users in general has been essential to help drive the project in the right direction and as we move to the next phase with SESAR 2020, that role remains as important as ever.*
>
> **Simon McNamara**, Director General, European Regions Airline Association

Reaching the performance ambition will require a change in the way that solutions are deployed, as well as possible evolutions in the way services are provided. Through a four-phase approach, this change would see the high-level architecture gradually moving from locally specific architecture to a more interoperable, common and flexible service provision infrastructure at regional or network level., as shown below:
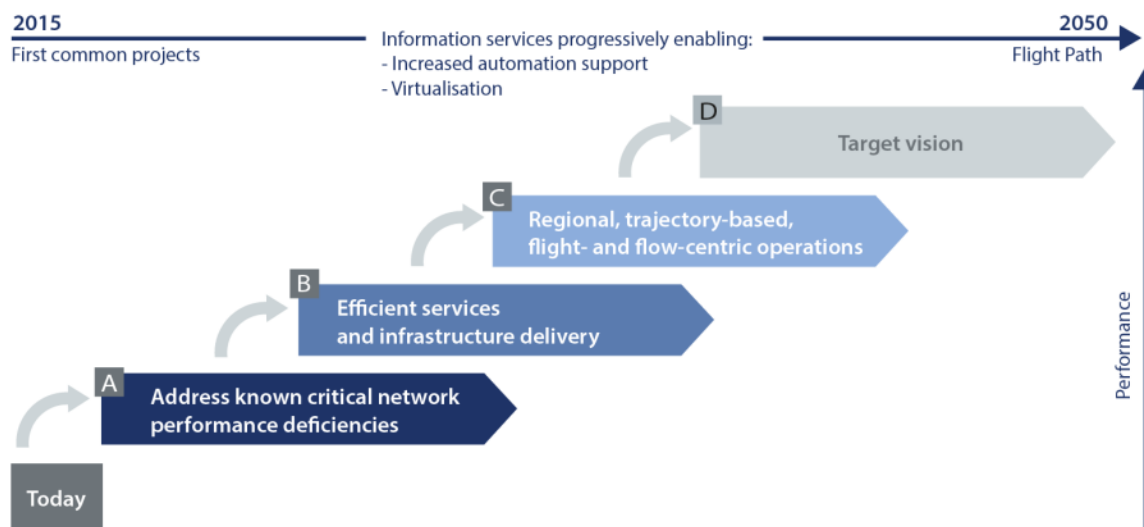


**Figure 34: The four – phase approach to improvements (from 2015 Ed. of the Master Plan)**

### IX.3.3.3.2    Closing the strategy to execution gap

Under SESAR 2020, the SJU intends to strengthen further and give more visibility to the consistency of all three levels of the Master Plan. As a result, all change to Level 2 (the dataset) shall be reviewed with a view to identifying any "significant change" that may affect significantly Level 1 – Executive – of the Master Plan, therefore justifying that the issue be tabled for the SJU Board attention and possibly decision.

Furthermore, any addition of implementation objective at Level 3 will necessarily be extracted from Level 2 and based on Business case and maturity check. Also, any deviation from the planned

implementation objectives shall be reported to the SJU Board through the transmission and approval of the Master Plan Level 3 implementation Plan.

In this way the Master Plan will be reinforced as the tool to bridge the gap between R&I and deployment and the main governance instrument to drive, steer and monitor the work of the programme.

To this effect an ongoing ATM Master Plan governance structure has started being implemented in 2017, through the setting up of a Master Planning Committee that advises the Executive Director of the SJU on any Master Plan execution issue.

### IX.3.3.3.3 Taking up new challenges

The new challenges of drones and cybersecurity have already been identified in SESAR 1 and Master Plan Edition 2015. Under SESAR 2020 they will be a priority of the programme.

The Vision and performance ambition shall also drive SESAR activities and the next Edition of the Master Plan shall provide the opportunity to check whether the programme is in line with expectations, or whether remedial actions should be taken.

Other expected challenges to tackle include:

- Rationalisation of infrastructure and the communications, navigation and surveillance (CNS) Roadmap.
- The possible mandate from the Commission to develop a proposal for a second common project
- The reinforcement of partnership and coordination with the SESAR Deployment Manager.
- The reinforcement of collaboration with EASA and with Standardisation bodies.

### IX.3.4 Conclusions

This document, prepared for SESAR 1 closure, allows highlighting that the SESAR 1 programme demonstrated a continuous effort to first federate and then focus, streamline and prioritise European ATM R&I, and also define a long term vision compliant with the highest level strategic documents.

Furthermore, since 2011 and the start of the Release process, SESAR has started to roll out Solutions mature for industrialisation and, since 2013, the outcome of SESAR 1 R&I has started being deployed and deliver performance benefits. At the time of SESAR 1 closure, on 31 December 2016, 61 performance-driven pre-industrialisation Solutions will have been delivered to the aviation community. A number of them have already been deployed or are at deployment stage, and it is from these mature Solutions that were selected and extracted the ATM functionalities that composed the Pilot Common Project adopted in June 2014 by the European Commission.

This combination of performance-driven R&I and concrete delivery of Solutions allows placing SESAR 2020 on the right track to deliver the technology that will enable "high-performing aviation for Europe" with its full potential being unleashed by 2035, when all R&I planned will have been effectively and efficiently been deployed.

As the review of SESAR 1 and the 2015 European ATM Master Plan clearly indicate, the landscape and challenges of ATM and aviation are evolving fast. This requires focused, but also adaptable and agile research in ATM technologies and procedures, and a powerful and collegial institutional

framework including partnerships with all stakeholders to ensure that change can be managed in a safe, efficient, cost-effective and environmentally responsible way.

SESAR 2020 is designed to tackle these challenges and demonstrate that it is as agile and adaptable as SESAR 1 was. At the time of SESAR 1 closure and start of SESAR 2020, Europe is now well on its way to building the ATM system that it needs to increase the performance and sustainability of its aviation sector.

**Annex A: ATM in the air transport value chain: The importance of aiming for high-performance**

Air travel is no longer reserved for the elite; instead it is something that more and more people find easy and affordable. With the rapid rise of a global middle class with a disposable income, this trend will continue to increase worldwide.

Europe has an opportunity to tap into this surge in global air travel by delivering a more attractive passenger experience through:

- High safety standards
- Affordable tickets
- Shorter and more punctual flights
- Greater mobility and choice
- Reduced environmental footprint

While unseen and unnoticed by passengers, air traffic management (ATM) is an essential part of air transport, playing several important roles:

- Acts as a guardian of safety
- Connects European cities and Europe with the rest of the world
- Adresses climate change by enabling green and efficient routes
- Maximises current infrastructure while delivering advanced information services
- Acts as a catalyst for Europe's competitiveness and innovative capacity

**2012**
9.5 million flights*

**2035**
14.4 million flights*

0.7 billion passengers**

1.4 billion passengers**

**What air transport brings to Europe**

€ EUR 220 billion to EU GDP
45 million jobs***

**European ATM in numbers**

11.5 million km² of airspace*

63 + En route centres*

58.000 Employees*

17.200 Air Traffic Controllers*

Sources: * Eurocontrol, ** ACI Europe, *** Report of the High-Level Group on Aviation Research, 2011

## Annex B: The 61 SESAR Solutions reaching V3 maturity at the end of SESAR 1

| | | Completed SESAR Solution ID | SESAR Solution Title | Stakeholders | Type of Solution | PCP AF | SESAR Release |
|---|---|---|---|---|---|---|---|
| Key Feature: Advanced air traffic services | 1 | #62 | Precision area navigation (P-RNAV) in a complex terminal airspace | ANSP<br>AU | ATM Solution | AF#1.2 | Release 1 |
| | 2 | #103 | Approach Procedure with vertical guidance | ANSP<br>AU | ATM Solution | AF#1.2 | Release 1 |
| | 3 | #104 | Sector team operations - en-route air traffic organiser | ANSP | ATM Solution | | Release 1 |
| | 4 | #60 | Enhanced short-term conflict alert (STCA) for terminal manoeuvring areas (TMAs) | ANSP | ATM Solution | | Release 1 |
| | 5 | #105 | Enhanced airborne collision avoidance system (ACAS) | ANSP<br>AU | ATM Solution | | Release 1 |
| | 6 | #65 | User-preferred routing | ANSP<br>AU<br>Network Manager | ATM Solution | AF#3.2 | Release 2 |
| | 7 | #63 | Multi-sector planning | ANSP | ATM Solution | | Release 2 |
| | 8 | #107 | Point merge in complex terminal airspace | ANSP | ATM Solution | | Release 2 |
| | 9 | #108 | Arrival management (AMAN) and point merge | ANSP | ATM Solution | | Release 2 |
| | 10 | #69 | Enhanced short-term conflict alerts (STCA) with downlinked parameters | ANSP | ATM Solution | | Release 3 |
| | 11 | #05 | Extended Arrival Management (AMAN) horizon | ANSP | ATM Solution | AF#1.1 | Release 4 |
| | 12 | #51 | Enhanced terminal operations with LPV procedures | ANSP<br>AU | ATM Solution | AF#1.2 | Release 4 |
| | 13 | #06 | Controlled time of arrival (CTA) in medium-density/medium-complexity environments | ANSP<br>AO<br>AU<br>Network Manager | ATM Solution | | Release 5 |
| | 14 | #08 | Arrival management into multiple airports | ANSP<br>AO | ATM Solution | | Release 5 |
| | 15 | #09 | Enhanced terminal operations with RNP transition to ILS/GLS | ANSP<br>AU | ATM Solution | AF#1.2 | Release 5 |
| | 16 | #10 | Optimised route network using advanced required navigation performance (RNP) | ANSP<br>AU<br>Network Manager | ATM Solution | | Release 5 |
| | 17 | #11 | Continuous descent operations (CDO) using point merge | ANSP | ATM Solution | | Release 5 |
| | 18 | #27 | Enhanced tactical conflict detection & resolution (CD&R) services and conformance monitoring tools for en-route | ANSP | ATM Solution | | Release 5 |
| | 19 | #32 | Free Route through the use of Direct Routing for flights both in cruise and vertically evolving in cross ACC/FIR borders and in high complexity environments | ANSP<br>AU<br>Network Manager | ATM Solution | AF#3.2 | Release 5 |

| | Completed SESAR Solution ID | SESAR Solution Title | Stakeholders | Type of Solution | PCP AF | SESAR Release |
|---|---|---|---|---|---|---|
| 20 | #33 | Free Route through the use of Free Routing for flights both in cruise and vertically evolving in cross ACC/FIR borders and within permanently low to medium complexity environments | ANSP AU Network Manager | ATM Solution | | Release 5 |
| 21 | #113 | Optimised low-level instrument flight rules (IFR) routes for rotorcraft | ANSP AU | ATM Solution | | Release 5 |
| 22 | #67 | AOC data increasing trajectory prediction accuracy | ANSP AU | ATM Solution | | Release 2 |
| 23 | #34 | Digital integrated briefing | ANSP AO AU Network Manager | ATM Solution | | Release 5 |
| 24 | #35 | Meteorological information exchange | ANSP AO AU Network Manager | Technological Solution | AF#5.4 | Release 5 |
| 25 | #37 | Extended flight plan | ANSP AU Network Manager | ATM Solution | AF#4.4 | Release 5 |
| 26 | #46 | Initial system-wide information management (SWIM) technology solution | ANSP AO AU Network Manager | Technological Solution | AF#5.1, AF#5.2, AF#5.3, AF#5.5 | Release 5 |
| 27 | #100 | ACAS ground monitoring system and presentation system | ANSP AU | Technological Solution | | Release 5 |
| 28 | #101 | Extended Hybrid Surveillance | ANSP AU AO | Technological Solution | | Release 5 |
| 29 | #102 | Aeronautical mobile airport communication system (AeroMACS) | ANSP AU AO | Technological Solution | | Release 5 |
| 30 | #109 | Air traffic services (ATS) datalink using Iris Precursor | ANSP AU | Technological Solution | | Release 5 |
| 31 | #110 | ADS-B surveillance of aircraft in flight and on the surface | ANSP AU | Technological Solution | | Release 5 |
| 32 | #114 | Composite surveillance (ADS-B/WAM) | ANSP AU | Technological Solution | | Release 5 |
| 33 | #115 | Extended projected profile (EPP) availability on ground | | Technological Solution | AF#6.1 | Release 5 |

Key Feature: Enabling Aviation Infrastructure

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| | Completed SESAR Solution ID | SESAR Solution Title | Stakeholders | Type of Solution | PCP AF | SESAR Release |
|---|---|---|---|---|---|---|
| 34 | #106 | Departure manager (DMAN) baseline for integrated AMAN DMAN | ANSP AO | ATM Solution | AF#2.1 | Release 1 |
| 35 | #61 | A low-cost and simple departure data entry panel for the airport controller working position | ANSP AO AU Network Manager | ATM Solution | | Release 1 |
| 36 | #64 | Time-based separation | ANSP AO | ATM Solution | AF#2.3 | Release 2 |
| 37 | #70 | Enhanced Ground Controller Situation Awareness in all Weather Conditions | ANSP AU | ATM Solution | | Release 3 |
| 38 | #71 | ATC and AFIS service in a single low density aerodrome from a remote CWP | ANSP | ATM Solution | | Release 3 |
| 39 | #52 | Remote Tower for two low density aerodromes | ANSP | ATM Solution | | Release 4 |
| 40 | #53 | Pre-Departure Sequencing supported by Route Planning | ANSP AO | ATM Solution | AF#2.1 | Release 4 |
| 41 | #54 | Flow based Integration of Arrival and Departure Management | ANSP AO | ATM Solution | | Release 4 |
| 42 | #55 | Precision approaches using GBAS CAT II/III based on GPS L1 | ANSP AU | ATM Solution | | Release 4 |
| 43 | #01 | Runway status lights | ANSP AO | ATM Solution | | Release 5 |
| 44 | #02 | Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances | ANSP AO AU | ATM Solution | AF#2.5 | Release 5 |
| 45 | #04 | Enhanced traffic situational awareness for vehicle drivers | ANSP AO | ATM Solution | | Release 5 |
| 46 | #12 | Single remote tower operations for medium traffic volumes | ANSP | ATM Solution | | Release 5 |
| 47 | #13 | Remotely-provided air traffic services for contingency situations at aerodromes | ANSP | ATM Solution | | Release 5 |
| 48 | #21 | Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP) | ANSP AO AU Network Manager | ATM Solution | AF#2.1 (AF#4.2) | Release 5 |
| 49 | #22 | Automated assistance to controllers for surface movement planning and routing | ANSP AO | ATM Solution | AF#2.4 | Release 5 |
| 50 | #23 | D-TAXI service for controller-pilot datalink communications (CPDLC) application | ANSP AO AU | ATM Solution | | Release 5 |

Key feature: High-performing airport operations

Founding Members

EUROPEAN UNION     EUROCONTROL

| | Completed SESAR Solution ID | SESAR Solution Title | Stakeholders | Type of Solution | PCP AF | SESAR Release |
|---|---|---|---|---|---|---|
| 51 | #47 | Guidance assistance through airfield ground lighting | ANSP<br>AO | ATM Solution | | Release 5 |
| 52 | #48 | Virtual block control in low-visibility procedures | ANSP<br>AO | ATM Solution | | Release 5 |
| 53 | #116 | De-icing management tool | | Technological Solution | | Release 5 |
| 54 | #66 | Automated support for dynamic sectorisation | ANSP<br>AU<br>Network Manager | ATM Solution | AF#3.1 | Release 2 |
| 55 | #56 | Enhanced ATFM Slot Swapping | ANSP<br>AO<br>AU<br>Network Manager | ATM Solution | | Release 4 |
| 56 | #57 | UDPP Departure | ANSP<br>AO<br>AU<br>Network Manager | ATM Solution | | Release 4 |
| 57 | #17 | Advanced short-term ATFCM measures (STAMs) | ANSP<br>AU<br>Network Manager | ATM Solution | AF#4.1 | Release 5 |
| 58 | #18 | Calculated take-off time (CTOT) and target time of arrival (TTA) | ANSP<br>AO<br>AU<br>Network Manager | ATM Solution | AF#4.3 | Release 5 |
| 59 | #19 | Automated support for traffic complexity detection and resolution | ANSP<br>AU<br>Network Manager | ATM Solution | AF#4.4 | Release 5 |
| 60 | #20 | Initial collaborative network operations plan (NOP) | ANSP<br>AO<br>AU<br>Network Manager | ATM Solution | AF#4.2 | Release 5 |
| 61 | #31 | Variable profile military reserved areas and enhanced civil-military collaboration | ANSP<br>AU<br>Network Manager | ATM Solution | AF#3.1 | Release 5 |

**Key feature: Optimised ATM network services** (rows 54–61)

# Annex C: Key figures on budget and allocation per OFA

## Annex 1 - SESAR 1 budget

*all amounts in euro*

| Revenue | in cash | in kind | Total |
|---|---|---|---|
| EU | 700,000,000 | 0 | 700,000,000 |
| Eurocontrol | 165,000,000 | 505,174,405 | 670,174,405 |
| Members | 27,824,089 | 556,481,775 | 584,305,864 |
| Total | 892,824,089 | 1,061,656,180 | 1,954,480,269 |

| Expenditure Ttile | Payments by SJU | Members' contribution | Total |
|---|---|---|---|
| 1&2 - Staff + administrative | 97,824,089 | 0 | 97,824,089 |
| 3.1 - Studies by SJU | 231,878,000 | 0 | 231,878,000 |
| 3.2 - Studies by Eurocontrol | 7,000,000 | 58,351,527 | 65,351,527 |
| 3.3 - Studies by the members | 556,122,000 | 1,003,304,653 | 1,559,426,653 |
| Total | 892,824,089 | 1,061,656,180 | 1,954,480,269 |

## Annex 2 - SESAR 1 implementation rate (end 2015)

*all amounts in euro*

| Ttile | Spending by SJU | Members' contribution | Total | Budget | Implementation rate |
|---|---|---|---|---|---|
| A01 - Staff | 35,371,929 | 0 | 35,371,929 | 57,824,089 | 61% |
| A02 - Administrative | 19,849,206 | 0 | 19,849,206 | 35,000,000 | 57% |
| B031 - Studies by SJU | 152,800,174 | 0 | 152,800,174 | 231,878,000 | 66% |
| B032 - Studies by Eurocontrol | 7,000,000 | 0 | 7,000,000 | 65,351,527 | 11% |
| B033 - Studies by the members | 453,810,042 | 787,152,706 | 1,240,962,748 | 1,559,426,653 | 80% |
| TOTAL | 668,831,351 | 787,152,706 | 1,455,984,057 | 1,954,480,269 | 74% |

## Annex 3 - SESAR 1 Implementation rate per key feature (end 2015)

*all amounts in euro*

| Key feature | Budget | % of total budget | Spending 2008-2015 | Implementation rate |
|---|---|---|---|---|
| Advanced air traffic services | 429,941,265 | 28% | 334,193,042 | 78% |
| Enabling aviation Infrastructure | 504,146,408 | 32% | 413,690,940 | 82% |
| High-performing airport operations | 366,918,970 | 24% | 299,977,619 | 82% |
| Optimised ATM network services | 258,420,011 | 17% | 193,101,146 | 75% |
| TOTAL | 1,559,426,653 | | 1,240,962,748 | 80% |

Founding Members

**Annex 4 - SESAR 1 OFA implementation rate (end 2015)**

| OFA Code | OFA Name | Spending 2008-2015 | Budget | Implemenation rate |
|---|---|---|---|---|
| ENB01.01.03 | Communication | 46,473,646 | 54,517,590 | 85% |
| ENB01.01.04 | Navigation | 13,554,334 | 15,538,709 | 87% |
| ENB01.01.05 | Surveillance | 16,915,362 | 19,350,755 | 87% |
| ENB02.01.01 | SWIM | 53,849,627 | 69,124,537 | 78% |
| ENB02.01.02 | AIM/MET | 15,831,098 | 26,536,853 | 60% |
| ENB03.01.01 TMF | TMF | 55,765,465 | 60,973,206 | 91% |
| OFA01.01.01 | LVPs using GBAS | 51,288,749 | 65,891,623 | 78% |
| OFA01.01.02 | Pilot enhanced vision | 10,097,791 | 10,236,609 | 99% |
| OFA01.02.01 | Airport safety nets | 33,501,191 | 43,594,542 | 77% |
| OFA01.03.01 | Enhanced Runway Throughput | 58,229,089 | 75,229,590 | 77% |
| OFA02.01.01 | Optimised 2D/3D Routes | 18,063,394 | 21,822,412 | 83% |
| OFA03.01.03 | Free Routing | 61,412,494 | 91,793,954 | 67% |
| OFA03.01.04 | Business and Mission Trajectory | 32,254,709 | 40,224,473 | 80% |
| OFA03.02.01 | ASAS Spacing | 26,444,041 | 30,602,273 | 86% |
| OFA03.02.03 | ATSA-ITP | 7,876,950 | 8,073,518 | 98% |
| OFA03.02.04 | ASEP | 14,857,108 | 16,395,137 | 91% |
| OFA03.03.01 | Ground Based Separation Provision in En Route | 32,688,151 | 39,701,706 | 82% |
| OFA03.03.02 | Ground Based Separation Provision in the TMA | 28,331,893 | 40,920,304 | 69% |
| OFA03.04.01 | Enhanced Ground Based Safety Nets | 8,154,975 | 10,565,210 | 77% |
| OFA03.04.02 | Enhanced ACAS | 9,787,250 | 10,328,061 | 95% |
| OFA04.01.01 | Integrated Arrival/Departure Management at Airports | 21,563,069 | 28,637,446 | 75% |
| OFA04.01.02 | Enhanced Arrival & Departure Management in TMA and En Route | 62,074,182 | 77,044,249 | 81% |
| OFA04.02.01 | Integrated Surface Management | 50,691,364 | 55,268,456 | 92% |
| OFA05.01.01 | Airport Operations Management | 41,938,689 | 54,427,091 | 77% |
| OFA05.03.01 | Airspace Management and AFUA | 8,591,148 | 18,620,391 | 46% |
| OFA05.03.03 | Dynamic Airspace Configurations | 8,980,336 | 20,179,794 | 45% |
| OFA05.03.04 | Enhanced ATFCM processes | 28,633,262 | 29,815,875 | 96% |
| OFA05.03.06 | UDPP | 13,565,056 | 21,297,968 | 64% |
| OFA05.03.07 | Network Operations Planning | 16,701,340 | 22,960,488 | 73% |
| OFA06.01.01 | CWP Airport | 27,138,732 | 28,743,884 | 94% |
| OFA06.02.01 | CWP En Route and TMA | 10,178,098 | 15,836,256 | 64% |
| OFA06.03.01 | Remote Tower | 20,799,502 | 24,747,170 | 84% |
| **TOTAL** | | 906,232,094 | 1,149,000,130 | 79% |