CONSOLIDATED ANNUAL ACTIVITY REPORT 2019

SESAR
JOINT UNDERTAKING

EDITION 01.00

Founding Members

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Foreword

Delivering the digital revolution in air traffic management

Aviation and air traffic management is today facing challenges it has not experienced since the beginning of commercial aviation. But I am in no doubt that this resilient and future oriented industry will turn a new page, and continue to provide excellent connectivity and innovative solutions. The current crisis has put tremendous pressure on European ATM systems, reminding us again how critical it is for aviation to have an operating environment that is more resilient, efficient and sustainable. The results achieved and the significant progress made by the SESAR JU before the COVID 19 crisis, presented in this report, will certainly help us to support recovery.

Through close collaboration, our partnership has succeeded in accelerating the innovation lifecycle and is already delivering a first set of solutions, within the current programme. I am very much looking forward to the implementation of these solutions as soon as possible. Our people and businesses want smarter and more sustainable air travel, and I know that together we can deliver it.

I am also very pleased to see the SESAR JU engaging with the broader stakeholder community to reach a consensus on future priorities. It is essential to listen to all stakeholders and to make the right choices – this is enshrined in the European Air Traffic Management Master Plan. The plan sets out a clear path towards a Digital European Sky and the technologies needed to get there, matching the ambitions of the 'European Green Deal' and the 'Europe fit for the digital age' initiative. I am sure we will see the SESAR JU rise to the challenge and provide excellent input for the whole aviation value network.

Henrik Hololei, Director-General of the European Commission's Directorate-General for Mobility and Transport (DG MOVE) and Chairman of the SESAR JU Administrative Board

The digital transformation of Europe's aviation infrastructure is of such a scale and complexity that no one stakeholder can do it alone. The job can only be achieved through effective cooperation, which is at the heart of the SESAR Joint Undertaking.

The ability of our partnership to drive transformational change was clear to see in 2019. Over the 12 months, we succeeded in accelerating the pace of innovation within the programme, moving from concepts to tangible solutions and delivering them in nearly half the time that the process had taken before SESAR. The benefits of these solutions were illustrated through live trials and demonstrations over the course of the year, paving the way for market uptake.

The engagement with stakeholders and sense of partnership also grew in 2019, especially in the area of U-space and drone activities. A portfolio of U-space projects brought together an unprecedented number and range of actors from traditional aviation, but also new entrants, to research and develop the services and technological capabilities needed to ensure the safe and secure integration of drones. The project outcomes are informing the regulatory and standardisation work under way by EASA and EUROCAE – both organisations were closely involved in the research throughout.

Finally, 2019 saw a growing consensus on the the need to implement a digital European sky, with the SESAR Joint Undertaking partnership working with the wider stakeholder community to detail the

direction, research priorities and deployment roadmaps in key strategy publications, namely the European ATM Master Plan, Airspace Architecture Study and Transition Plan.

These achievements demonstrate the power of the SESAR JU partnership to transform Europe's aviation infrastructure, with a view to making air transport smarter, more sustainable, more connected and accessible to all.

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 2019 (CAAR 2019) and, having reviewed the document, notes that:

- The SESAR JU met all its key policy and operational objectives in 2019 as outlined in the Single Programming Document for the period 2019-2021;

- The SESAR JU's key achievements in 2019 were the following:

    o the finalisation of the Airspace Architecture study, launched in 2018, and the development of its Transition Plan on request from the Commission,

    o the finalisation of the European Master Plan edition 2020 and its adoption by the Administrative Board of the SESAR JU,

    o the completion of the SESAR 2020 programme Wave 1, resulting in the delivery of 21 SESAR Solutions ready for industrialisation, and the preparation for the delivery of nine additional Solutions in early 2020,

    o the grant agreement preparation and signature for the Wave 2 grants for industrial research and validation and for demonstrations, and the launch of the first 13 Wave 2 projects,

    o the preparation, launch and follow-up of the fourth exploratory research call,

    o the supervision of 70 projects covering all phases of research and innovation of the SESAR 2020 programme (17 projects related to exploratory research, 32 to industrial research and validation, and 21 to very large-scale demonstrations),

    o the organisation of and/or participation at major European and global events related to air traffic management and aviation, including the World ATM Congress, SESAR Innovation Days, the Paris Air Show and several ICAO events,

    o the communication of programme results and the promotion of scientific excellence through dedicated initiatives (the update of the Solution Catalogue 3rd Edition, the SESAR Digital Academy, the Young Scientist Awards, the SESAR Digital Sky Challenge),

    o the legal, financial and administrative support to the SESAR JU operations in compliance with the regulatory requirements applicable to the SESAR JU,

    o the delivery of corporate tools and initiatives to secure the efficiency of the SESAR JU operations;

- The SESAR JU 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 throughout the year 2019;

- The main risks for the delivery of the SESAR JU'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 2019 accurately and adequately describes the work performed by the SESAR JU in 2019.

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Executive summary

In 2019, the SESAR JU made significant progress in delivering the research and innovation objectives of the SESAR 2020 programme, while preparing for the future and the transition towards the Digital European Sky. It achieved all its objectives as outlined in the Single Programming Document 2019–2021, which in 2019 was structured in six strategic areas of operations:

- Provide strategic steering to the SESAR Programme;

- Deliver exploratory research;

- Deliver industrial research and validation;

- Deliver very large-scale demonstrations;

- Deliver SESAR outreach activities;

- Deliver effective financial, administrative and corporate management.

This section reflects the key achievements and main outcomes of the SESAR JU across these strategic areas in 2019.

A year of vision

The year 2019 saw the publication of a number of key strategic documents, setting out the vision, strategies and roadmaps for delivering smarter, more seamless, sustainable and safer air transport.

In March, the SESAR JU published the Airspace Architecture Study, which presented a new approach to Europe's airspace architecture that leverages modern technologies and decouples service provision from local infrastructure. It was followed in September by the Transition Plan, setting out three key operational and technical measures that need to be put in place in the short term (2020 to 2025) in order to set in motion the transformational changes outlined in the Study.

In December, the SESAR JU Administrative Board adopted the European ATM Master Plan (2020 edition), setting the direction for the delivery of the Digital European Sky enabling it to handle the future growth and diversity of air traffic safely and efficiently, while establishing Europe as the most environmentally friendly sky to fly in the world.

A year of delivery

Building on progress made in previous years, the SESAR JU delivered tangible results across all three phases of research and innovation: exploratory research, industrial research and validation, and very large-scale demonstrations. These outcomes mean that the SESAR JU is on track to meeting the research and innovation objectives and timeline as outlined in European ATM Master Plan (2015 edition).

Exploratory research (ER)

Further to the 28 ER1 projects closed in 2018, work was completed in 2019 by a total of 17 projects in the fields of fundamental and applied research aimed at fostering new ideas and knowledge transfer in ATM in Europe. Within the ER2-RPAS call, 6 projects were focused on U-space, the European Union's initiative to ensure the safe and secure integration of drones. One of the projects (CORUS) developed the U-space concept of operations, the others addressed information management, on-board and

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ground-based technology for CNS of drones and other technology needed for more advanced U-space capabilities (U3/U4). All projects worked in close collaboration with the U-space demonstration projects that focus on U1/U2 services. The SESAR JU will consolidate the results of these projects together with the results of the U-space demonstration projects to provide a coherent picture.

The ER3 projects addressed ATM topics (architecture, CNS, trajectory-based operations) and one of them (Engage) is the SESAR Knowledge Transfer Network (KTN); it aims to disseminate, promote and support the development of air traffic management (ATM) research in Europe.

The SESAR JU made a critical analysis of the outcomes of the ER1 projects, which served in particular to define the content of the ER4 call, which was launched in 2019.

These ER projects bring together over 200 beneficiaries from all over Europe, of which more than half are higher-education organisations or research centres.

Additional to the ER projects, the SESAR JU organised the SESAR Innovation Days, the main ATM-related event on exploratory research, which included the Young Scientist Award and the launch of the SESAR Digital Academy

Industrial research and validation (IR/VLD)

In 2019, the first wave of SESAR 2020 industrial research, namely 20 'Wave 1' projects, came to a close as part of Release 9, delivering 21 solutions ready for industrialisation and preparing for the delivery of 9 more in early 2020. The main Wave 1 solutions ready for industrialisation cover the development of the technical infrastructure required for the virtual centre concept; the validation of multiple remote tower operations; the development of enhanced and synthetic (EVS/SVS) vision systems for take-off and landing operations in low-visibility conditions; the enhancement of on-board systems to detect potential and actual risks of collision with other traffic during runway and taxiway operations; optimised traffic management to enable free routing in high/very high complexity environments and the development of enhanced procedures to mix rotorcraft and general aviation traffic in the terminal manoeuvring areas (TMA).

In parallel to the first wave of the IR/VLD programme, the SESAR JU launched the Wave 2 call, the evaluation of which was completed in July 2019 and with all grants for IR projects signed by December 2019. This enables the Wave 2 solutions development activities to be launched as of 1 January 2020. The key solutions to be addressed by the Wave 2 projects cover dynamic airspace configuration, flight centric air traffic control (ATC) operations, further development of the operational procedure for the virtual centre concept (e.g. delegation of ATS services), the RPAS integration into instrument flight rules (IFR) in controlled airspace and collision avoidance, future satellite communication datalink technologies or dual frequency/multi-constellation ground-based augmentation system (GBAS) operations.

These IR projects bring together 125 beneficiaries from all over Europe, of which 80 % are private companies (of which 8 % are SMEs), 10 % are research centres, 5 % are higher-education organisations and 5 % are public organisations.

The SESAR 2020 programme has demonstrated the added value of an institutional partnership in achieving greater impact at an accelerated pace: while in SESAR 1 a solution needed on average 10 years for development to reach a "ready for industrialisation" maturity level, in SESAR 2020 the average required time is 6 years.

Very large-scale demonstrations

Seven demonstration projects were completed, while 14 are still in progress and will complete their activities in 2020.

These demonstrations showcased the benefits of solutions already delivered in SESAR 1, addressing network collaborative management, air navigation services, airport operations centres and airspace users' flight operations centres; arrival management extended to en-route airspace, integrated airport operations, and ATM improvements generated by initial trajectory sharing ("extended projected profile"). Six projects were focused on U-space, with progress being made to showcase already matured U-space services and technologies for visual line of sight (VLOS) and beyond visual line of sight (BVLOS) drone flights. The scope covers operations in rural and urban areas, in the vicinity of airports, in uncontrolled and controlled airspace, and in mixed environments with manned aviation. Projects examined, for example, how to handle very low level (VLL) operations where general aviation, commercial aviation and drones share the airspace.

The demonstration projects gathered 80 beneficiaries from 16 European countries of which 37 % are SMEs.

A year of outreach

In 2019, the SESAR JU collaborated with the European Commission, ECAC States and European aviation organisations to secure SESAR's position as a global leader in ATM modernisation in support of the sixth edition of ICAO's Global Air Navigation Plan (GANP) which was endorsed during the 40th ICAO Assembly. Through a common European line, the European ATM Master Plan, the European Aviation Safety Plan and the SESAR ATM modernisation programme maintained a leading role in the evolution of the ICAO Global Air Navigation Plan (GANP)/Aviation System Block Upgrades (ASBUs) and the Global Aviation Safety Plan.

In order to maintain a high level of engagement with stakeholders in 2019, the SESAR JU participated in a wide range of events, including the World ATM Congress which took place in March 2019 in Madrid and brought together the European Commission, Eurocontrol and other institutional aviation partners under the theme "Europe for Aviation". The Congress hosted 8 000 visitors in total, numerous exhibitions, and presentations. The SESAR JU, in collaboration with its Members, organised 16 walking tours enabling the participants to meet with the aviation experts and learn about the solutions already delivered by the SESAR JU that are being implemented across Europe.

In June, the SESAR JU showcased the results of its research and innovation programme at the International Paris Air Show at Le Bourget. At a stand in the Paris Air Lab - a space dedicated to innovation in the aerospace industry - visitors had an opportunity to meet representatives from the SESAR JU and experts in the fields of airports, air traffic service provision, enabling technologies and drones to discuss all aspects of SESAR research and the results delivered so far.

In December, the SESAR JU organised the SESAR Innovation Days in Athens, showcasing European exploratory research on air traffic management (ATM) and celebrating young talent with the SESAR Young Scientist Award. The SESAR Innovation Days was a perfect backdrop to organise the Digital Sky Challenge, an innovation sprint of 48 hours where 12 competing teams from across Europe were asked to come up with solutions addressing safety, environment and a better passenger experience. Taking place at Athens Airport, the Challenge showed what could be achieved by harnessing big data and AI technologies for aviation.

Altogether, in 2019 the SESAR JU staff participated in almost 120 aviation events worldwide, presenting the activities of the SESAR JU and maintaining a high profile among the stakeholders and members.

The SESAR JU communicated about its work through the printing and promotion of the following publications: Airspace Architecture Study and its Transition Plan, SESAR Concept of Operations for U-

space, SESAR Solutions Catalogue - Third edition (2019), Final Project Reports for 11 exploratory research projects, European ATM Master Plan, Digital European Sky brochure, and SESAR Innovation Pipeline – 2019 Highlights.

In addition, the SESAR JU continued its outreach to target audiences with more than 15 featured articles and interviews published in a number of magazines, including specialised and general media, as well as online media. The SESAR JU succeeded in increasing its presence across its social media channels and in more than doubling digital engagement with its stakeholder community.

In addition, in 2019, six research and innovation projects from the SESAR 2020 programme received a special recognition for their outstanding performance in the aviation industry in four out of six research and innovation categories aligned with the European ATM Master Plan objectives.

A year of preparation

In 2019, the SESAR JU made preparations for the next wave of research activities with a view to delivering the content of the European ATM Master Plan (2015 edition).

In the area of exploratory research, the fourth exploratory research call (ER4) was launched in the first quarter of 2019. A total of 128 proposals were received and evaluated, out of which 29 were awarded for a total value of EUR 37.7 million. The projects are expected to start in the second quarter of 2020. Some key topics of this call address digital information management, the use of artificial intelligence and machine learning as enablers for the ATM operations, further consideration of the environment and meteorological elements in the ATM operations or innovative technology for CNS operations.

Further to projects already in execution, the SESAR JU published a second call for proposals (IR-VLD Wave 2), restricted to its Members, for industrial research and demonstration activities. This call resulted in the selection and award of 12 new IR projects with a total value of EUR 130.5 million and one VLD project with a value of EUR 4.2 million. For these projects, the grant agreement preparation phase was completed successfully and they were launched into execution before the end of the year. The projects will run until the end of 2022. In addition, two new VLD projects were selected, for which the grant agreement preparation was still ongoing at the end of 2019. Overall, the IR-VLD Wave 2 call resulted in the award of grants for a total amount of EUR 147.2 million.

Preparations also got under way on the next restricted call for proposals (IR-VLD Wave 3), to be launched by the end of March 2020 and awarded by the third quarter 2020. The main objective of the Wave 3 call for proposal is to allow for an optimal coverage of the research and innovation topics of the SESAR 2020 programme, responding to the ATM Master Plan Phase C taking due account of the outcome of the Airspace Architecture Study.

Regarding very large-scale demonstrations, a second open call (VLD Open 2) was prepared and ready for publication in January 2020. The call content is structured in a number of topics covering the initialisation of the 'Digital European Sky demonstrators' as defined in the Airspace Architecture Study Transition Plan, demonstration of U-space capabilities and services to enable urban air mobility and the demonstration of ATM operations mitigating aviation's environmental footprint and significantly contributing to the reduction of CO_2 emissions.

In addition, the SESAR JU provided support to the European Commission on the technological aspects of the Single European Sky and specifically to prepare a possible future ATM research partnership.

A year of corporate improvements

The SESAR JU made several key improvements to its operations in 2019. These included publishing new Financial Rules[1], following the publication by the Commission of the new Framework Financial Regulation[2], as well as strengthening its finance function with the appointment of a Chief Financial Officer (recruited externally) in the new organisation chart.

Budget implementation increased compared to the last years with a rate of 91.69% for commitments and 82.66% for payments.

In the area of human resources, it implemented the human resources information system 'Sysper for Agencies', developed by the European Commission, which will be operational in the first quarter of 2020. Finally, the SESAR JU implemented automatic solutions to support administrative processes.

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[1] Annex to decision ADB(D)21-2019 of the SESAR JU Administrative Board
[2] Commission Delegated Regulation (EU) 2019/715 of 18 December 2018 on the framework financial regulation for the bodies set up under the TFEU and Euratom Treaty and referred to in Article 70 of Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council (OJ L 122, 10.5.2019, p. 1–38)

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1   Introduction

1.1   Background and objectives of the document

The SESAR JU established this Consolidated Annual Activity Report (CAAR) in accordance with Article 74(9) of the EU Financial Regulation[3] and Article 48 of the Framework Financial Regulation[4], Article 16 of the Statutes of the SESAR JU[5], and of Article 47 of the Financial Rules[6] of the SESAR JU.

This Consolidated Annual Activity Report (CAAR) has several purposes: it provides evidence of progress towards achieving the SESAR JU's key objectives as defined in the Single Programming Document for the period 2019 to 2021 (hereafter referred to as 'SPD 2019-2020') implementing the SESAR 2020 Multi-Annual Work Programme (MAWP)[7], taking into account resources used during the reporting period; it also outlines the management and oversight systems in place at the SESAR JU, including reference to the European Commission's Internal Control Framework. It includes a declaration of assurance in which the Executive Director, in his role as Authorising Officer, provides reasonable assurance regarding 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, and provides reasonable assurance that resources assigned to the activities in the CAAR have been used for their intended purpose and in accordance with the principle of sound financial management.

The SESAR JU has developed this CAAR in accordance with the guidelines set out in Communication from the Commission on the guidelines for programming document for decentralised agencies and the template for the CAAR for decentralised agencies[8].

1.2   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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[3] Regulation (EU, Euratom) No 2018/1046 of the European Parliament and of the Council of 18 July 2018 on the Financial Rules applicable to the general budget of the Union, amending Regulations (EU) No 1296/2013, (EU) No 1301/2013, (EU) No 1303/2013, (EU) No 1304/2013, (EU) No 1309/2013, (EU) No 1316/2013, (EU) No 223/2014, (EU) No 283/2014, and Decision No 541/2014/EU and repealing Regulation (EU, Euratom) No 966/2012 (OJ L 193, 30.7.2018, p. 1)

[4] Commission Delegated Regulation (EU) No 2019/715 of 18 December 2018 on the framework financial regulation for the bodies referred to in Article 70 of Regulation (EU, Euratom) No 2018/1046 of the European Parliament and of the Council (OJ L 122, 10.5.2019, p. 1–38)

[5] 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)

[6] Administrative Board decision ADB(D)21-2019

[7] The MAWP, which was approved by the Administrative Board in 2015, is updated through Single Programming Documents established each year; it can be consulted on the SESAR JU website: http://www.sesarju.eu/newsroom/brochures-publications/sesar-2020-multi-annual-work-programme

[8] Communication from the Commission 2020/2297 final 'on the strengthening of the governance of Union Bodies under Article 70 of the Financial Regulation 2018/1046 and on the guidelines for the Single Programming Document and the Consolidated Annual Activity Report'

In December 2015, the publication of "An Aviation Strategy for Europe"[9] by the European Commission 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 pursues the objectives to modernise 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.

1.3   The SESAR JU membership

The SESAR JU was created under Article 171 of the Treaty establishing the European Community and confirmed under Article 187 of the Treaty on the Functioning of 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 High-Level Goals of the Single European Sky (SES) initiative.

Founded by the European Union and Eurocontrol, established in 2007 as a joint undertaking[10], the SESAR JU became a Union Body in 2009. It was augmented by 15 stakeholder Members and then in 2016 four further Members acceded to membership, all committing to achieving the mission of the Joint Undertaking by 2024.

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

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

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Figure 1: SESAR JU membership from 2016 onwards

Together with their partners and affiliates, the SESAR JU Members other than the Union represent over 120 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.

1.4   The role and mission of the SESAR JU

Responding to the objectives of the EU Aviation Strategy and the Single European Sky, the challenges for ATM are captured by the SESAR JU in the European ATM Master Plan (currently 2015 Edition), which is the main planning tool for ATM modernisation in Europe. The role of the SESAR JU in coordinating and concentrating the SESAR research and innovation 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 research and innovation programme (called SESAR 1 for the period covering 2008 to 2016, and SESAR 2020 starting in 2015 with a maximum period for award of grants ending in December 2020), coordinated by the SESAR JU and performed by the industry at large. The figure below depicts the central role of the SESAR JU in driving and coordinating ATM research and innovation in relation to the Union Policy:
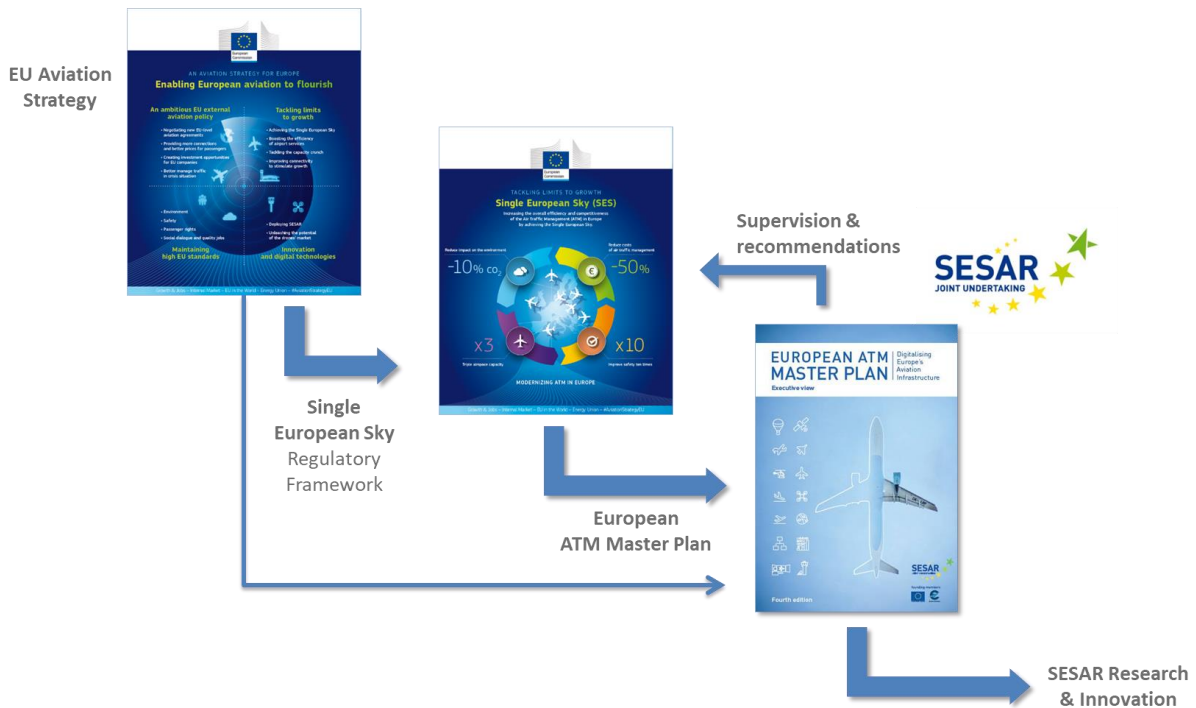
Figure 2: The central role of the SESAR JU in driving and coordinating ATM research in the Union

The SESAR 2020 activities are funded through four different funding instruments: the Horizon 2020 Framework Programme for Research and Innovation (H2020) for EUR 585 million, the Connecting Europe Facility (CEF) Programme for EUR 10 million for drone U-space demonstration activities, and two initiatives funded through assigned revenues for a value of EUR 500 000 and EUR 800 000 respectively. This represents a total funding from the European Union of EUR 596.3 million. The SESAR JU maintains full compliance with these frameworks.

The SESAR JU transfers the result of its ATM research and innovation activities in the form of SESAR Solutions[11] that are made available for deployment, and therefore makes a positive contribution towards the achievement of the Single European Sky. This relationship between the EU Aviation Strategy, 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 to deployment, is structured in the SESAR Innovation Pipeline, which is depicted in the figure below:

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[11] SESAR Solutions are referred to as 'candidate SESAR Solutions' as long as they are under development in the industrial research phase of the SESAR innovation pipeline (see figure 3). Once validated at V3 level of maturity, they are packaged and referred to as 'SESAR Solutions'
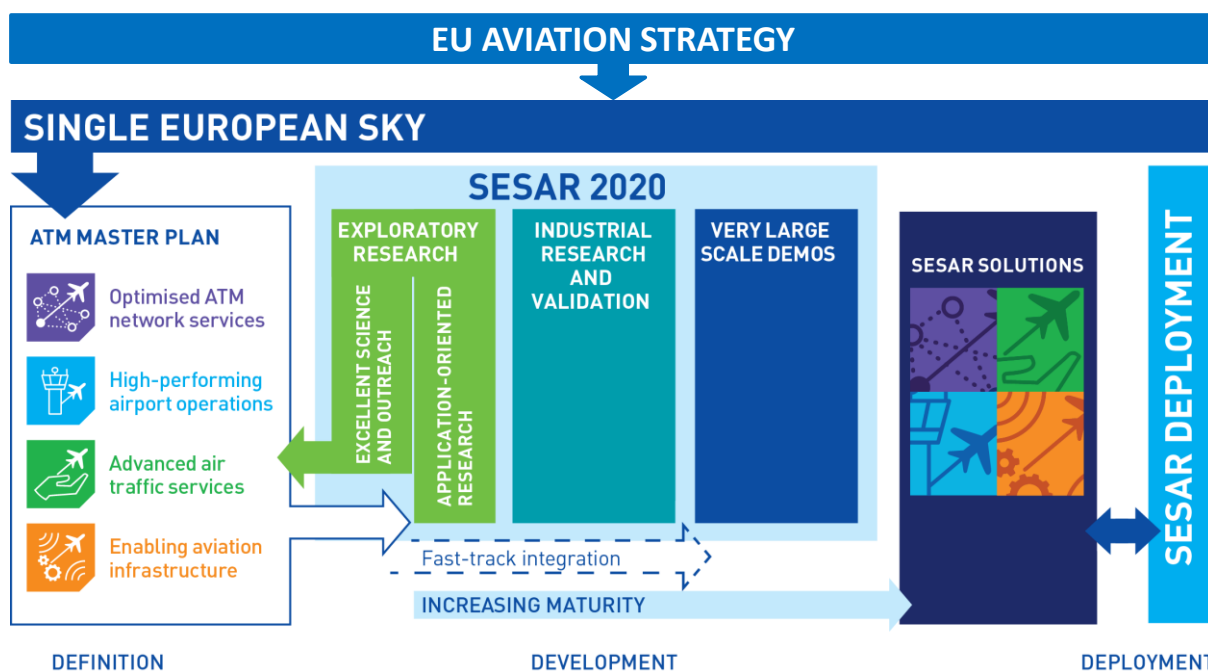
Figure 3: The SESAR Innovation Pipeline – from EU Aviation Strategy to SESAR Solutions

As depicted in figure 3, starting with the European ATM Master Plan which structures the ATM modernisation activities into four Key Features (Optimised ATM Network Services, High-performing airport operations, Advanced air traffic services and Enabling aviation infrastructure), the SESAR Innovation pipeline is organised in three main research and innovation phases which mature operational and technology solutions through the EOCVM (European Operational Concept Validation Methodology) well-established control and monitoring process linked to Technology Readiness Level (TRL):

- 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'). Exploratory research covers research activities up to TRL 2[12]. It also addresses the Knowledge Transfer Network aimed at facilitating the development of ATM research in Europe in support to the SESAR JU. This phase of research is wholly funded from EU funds and done in full compliance with H2020 and its rules for participation[13]. It is subject to open calls, allowing contributions from stakeholders beyond the membership including universities and research centres;

- 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 V3 / TRL 6.

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[12] 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

[13] Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 – the Framework Programme for research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006 (OJ L 347, 20.12.2013, p. 81–103)

- 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 demonstration activities provide the bridge between the development and deployment phases of SESAR. They are funded through the Horizon 2020 programme, or through the CEF Programme (for drone U-space demonstration activities) or through Assigned Revenue, through work undertaken by the SESAR JU Members other than the Union (through restricted calls), supplemented by open calls to ensure the widest possible stakeholder participation beyond the membership including small and medium enterprises (SMEs) and new entrants.

Solutions which are assessed with V3/TRL 6 level of maturity and a positive cost-benefit analysis are then transferred for deployment, either through Common Projects, or through other types of deployment activities (e.g. at the national level).

Additionally, the SESAR JU 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 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 ICAO.

1.5 Factsheet: the SESAR JU in 2019

The table below provides an overview of key facts and figures related to the SESAR JU in 2019:

Name	SESAR Joint Undertaking (SESAR JU)
Objectives	The SESAR JU 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 acts	Established under Council Regulation (EC) No 219/2007 of 27 February 2007[14] Modified by Council Regulation (EC) No 1361/2008 (SESAR JU Regulation)[15] Last amended by Council Regulation (EU) No 721/2014[16]
Executive Director	Florian Guillermet (mandate running until March 2022)
Administrative Board composition[17]	Members with voting rights: 1) SESAR JU Members • European Union (founding member) • Eurocontrol (founding member) • Airbus • AT-One consortium • B4-consortium • COOPANS consortium • Dassault Aviation • DFS • DSNA • ENAIRE • ENAV • Leonardo • Frequentis consortium • Honeywell • INDRA • NATMIG • NATS • SEAC 2020 • Skyguide • Thales LAS France SAS • Thales AVS France SAS 2) Representatives at European level of civil users of airspace:

[14] 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).

[15] 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).

[16] 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 Consoldating until 2024.

[17] As of 31 December 2016. A list of representatives in the Administrative Board is provided in Annex IX. Before 2016, the SESAR JU membership was composed of the two founding members (EU and Eurocontrol) and 15 additional members.

	Members without voting rights: • the military • ANSPs • equipment manufacturers • airports • staff in the ATM sector • the scientific community
Other advisory bodies	The Programme Committee (PC) and its sub-committees: the Delivery Management Sub-Committee (DMSC) and the Operations and Technical Sub-Committee (OTSC) The Scientific Committee (SC) The Master Planning Committee (MPC)
Human resources[18]	42 positions, of which 40 positions were filled by the end of 2019: • temporary agents: 39 positions, 38 filled (out of these 38 staff, 36 are temporary agents and 2 are contract agents covering a TA position) • seconded national experts: 3 positions, all filled 46% men / 54% women
Strategic research agenda	SESAR 2020 Multi-Annual Work Programme (MAWP) adopted by the SESAR JU Administrative Board in Decision ADB(D)05-2015: https://www.sesarju.eu/sites/default/files/documents/SESAR%202020%20Multi_Annual%20Work%20Programme%20V1.0.pdf

2019 Budget	Budget revenue:
	• Revenue entitlements (balancing commitments appropriations):
	➢ **Final adopted budget[19]: EUR 150 558 321**
	   o EU contribution: EUR 110 000 000 (only for SESAR 2020 programme)
	   o EFTA contribution EUR 2 618 000
	   o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)
	   o Unused appropriations from previous years: EUR 30 985 560
	➢ **Available appropriations: EUR 161 041 597**
	   o EU contribution: EUR 110 000 000 (only for SESAR 2020 programme)
	   o EFTA contribution EUR 2 618 000
	   o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)
	   o Unused appropriations from previous years: EUR 30 985 560 deducted from previous years revenue commitment appropriations[20]
	   o Automatic carried-over of assigned revenues: EUR 7 000 000
	   o Internal assigned revenue and internal assigned revenue carried-over: EUR 3 483 276
	➢ **Final budgetary inscriptions: EUR 119 572 762**
	   o EU contribution: EUR 110 000 000 (only for SESAR 2020 programme)
	   o EFTA contribution EUR 2 618 000
	   o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)

[18] As on 31 December 2019. Details on the implementation of the staff establishment plan are provided in Section 3.5

[19] The final budget for 2019 was adopted through the decision of the SESAR JU Administrative Board ADB(D)13-2019 adopting the third amended SESAR JU SPD 2019-2021

[20] When uploading the amending budget, C2 inscriptions are only posted in expenditure and are deducted in revenue from previous years

Founding Members

- Revenue to be cashed in (balancing payments appropriations)

➢ **Final adopted budget: EUR 169 857 198**

  o EU contribution: EUR 111 089 593 of H2020 funds

  o EFTA contribution: EUR 2 643 932

  o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)

  o Unused appropriations from previous years: EUR 44 168 911

  o Other external assigned revenue: EUR 5 000 000 (U-space Delegation Agreement)

➢ **Available appropriations: EUR 183 279 715**

  o EU contribution: EUR 113 733 525 (EUR 111 089 593 of H2020 funds plus EUR 2 643 932 of EFTA contribution)

  o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)

  o Unused appropriations from previous years: EUR 44 168 911 are deducted from previous years revenue payment appropriations[21]

  o Automatic carry-over of assigned revenues: EUR 5 000 000 (U-space Delegation Agreement)

  o Internal assigned revenue and internal assigned revenue carried-over: EUR 13 422 517

➢ **Final budgetary inscriptions: EUR 125 688 287**

  o EU contribution: EUR 113 733 525 (EUR 111 089 593 of H2020 funds plus EUR 2 643 932 of EFTA contribution)

  o Other revenue: EUR 6 954 762 (Eurocontrol and other members contributions to SESAR 2020 programme)

  o Automatic carried-over of assigned revenues: EUR 5 000 000 (U-space Delegation

The table below summarises all these appropriations:

Table 2 – Revenue

REVENUES	Final budget 2019 adopted		Additional appropriations		Total available appropriations		Automatic carry over		Budget Appropriations inscription	
	Commitment appropriations	111.733.525	Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations
EU contribution (EFTA included)	112.618.000	111.733.525	-	-	112.618.000	111.733.525	-	-	112.618.000	111.733.525
Assigned revenue	-	7.000.000	7.000.000	7.000.000	7.000.000	7.000.000	7.000.000	-	-	7.000.000
Other Members contribution	6.954.762	6.954.762	-	-	6.954.762	6.954.762	-	-	6.954.762	6.954.762
Administrative operations	-	-	3.483.276	13.422.517	3.483.276	13.422.517	3.483.276	13.422.517	-	-
Unused appropriations	30.985.560	44.168.911	-	-	30.985.560	44.168.911	30.985.560 -	44.168.911	-	-
TOTAL REVENUES	**150.558.321**	**169.857.198**	**10.483.276**	**13.422.517**	**161.041.597**	**183.279.715**	**20.502.283** -	**30.746.393**	**119.572.762**	**125.688.287**

Budget expenditure

- Commitment appropriations:

➢ **C1 appropriations as per final adopted budget: EUR 150 558 321**

  o Title I (staff expenditure): EUR 6 044 372

  o Title II (infrastructure and operating expenditure): EUR 3 612 935

  o Title III (operational expenditure): EUR 140 901 014

➢ **C4/C5/R0/C8 appropriations: EUR 10 483 276**

  o Title I (staff expenditure): EUR 10 609

  o Title II (infrastructure and operation expenditure): EUR 57 068

  o Title III (operational expenditure): EUR 10 415 599

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[21] When uploading the amending budget, C2 inscriptions are only posted in expenditure and are deducted in revenue from previous years

	- Payment appropriations: ➢ **Final adopted budget: EUR 169 857 198** ○ Title I (staff expenditure): EUR 6 044 372 ○ Title II (infrastructure and operating expenditure): EUR 3 612 935 ○ Title III (operational expenditure): EUR 160 199 891 ➢ **C4/C5/R0/C8 appropriations: EUR 13 422 517** ○ Title I (staff expenditure): EUR 339 683 ○ Title II (infrastructure and operating expenditure): EUR 876 809 ○ Title III (operational expenditure): EUR 12 206 026 Budget expenditure (total available all fund sources): **Commitment appropriations: EUR 161 041 597** ○ Title I (staff expenditure): EUR 6 054 981 ○ Title II (infrastructure and operating expenditure): EUR 3 670 003 ○ Title III (operational expenditure): EUR 151 316 614 **Payment appropriations: EUR 183 279 715** ○ Title I (staff expenditure): EUR 6 384 055 ○ Title II (infrastructure and operating expenditure): EUR 4 489 743 ○ Title III (operational expenditure): EUR 172 405 917
2019 Budget implementation	Implementation of budget revenue: - Revenue (recovery orders established balancing commitments): EUR 124 777 771 (104,4% of the available appropriations) ○ EU contribution: ▪ H2020 funds: EUR 113 733 525 ▪ Assigned revenue from the European Parliament: EUR 402 657 (out of which EUR 250 000 for Geo-fencing Delegation Agreement and EUR 152 657 for Architecture Study Delegation Agreement) ○ Eurocontrol contribution: EUR 1 848 266 (SESAR 2020 budget) ○ Other Members contribution: EUR 2 729 585 (SESAR 2020 budget) ○ Other revenue: EUR 6 063 737 (out of which EUR 5 148 227 for SESAR 2020 programme and EUR 915 510 for SESAR 1 Programme) - Revenues (cash received): EUR 124 777 771 (99,28% of the approved budget) Implementation of budget expenditure: - Actual commitment appropriations (commitments made on 2019 budget): EUR 147 659 809 (91,69% of the available appropriations): ○ Title I (staff expenditure): EUR 5 585 740 ○ Title II (infrastructure and operating expenditure): EUR 3 161 028 ○ Title III (operational expenditure): EUR 138 913 040 - Actual total payments made in 2019: EUR 151 504 679 (82,66% of the available appropriations) ○ Title I (staff expenditure): EUR 5 325 094 ○ Title II (infrastructure and operating expenditure): EUR 2 448 741 ○ Title III (operational expenditure): EUR 143 730 844 (of which EUR 142 845 562 from SESAR 2020 budget and EUR 885 282 from SESAR 1 budget)
Call implementation	A total of 10 calls for proposals were planned to be launched over the period 2015-2020: 2 calls (1 open, 1 restricted to the SESAR JU members other than the Union) launched in 2015 under the Horizon 2020 programme, resulting in:

	- o 28 exploratory research projects, with the corresponding grants signed with 88 beneficiaries and linked third-parties, for a total value of EUR 20.4 million, resulting from the open call H2020-SESAR-2015-1 (ER1) - o 20 industrial research and validation projects with the corresponding grants signed with the 20 SESAR JU members other than the Union (Eurocontrol and 19 other SESAR JU stakeholder members[22]) and linked third-parties, for a total value of EUR 206.7 million, resulting from the restricted call H2020-SESAR-2015-2 (IR/VLD Wave 1) - o 5 very large-scale demonstrations (one was terminated in 2017) with the corresponding grants signed with the 20 SESAR JU Members other than the Union (Eurocontrol and 19 other SESAR JU stakeholder Members[22][23]) and linked third-parties, for a total value of EUR 31.7 million resulting from the restricted call H2020-SESAR-2015-2 (IR/VLD Wave 1) • 2 additional open calls launched in 2016 under the Horizon 2020 programme, resulting in: - o 9 exploratory research projects focusing on RPAS with the corresponding grants signed with 43 beneficiaries and linked third-parties, for a total value of EUR 8.3 million, resulting from the open call H2020-SESAR-2016-1 (ER2-RPAS) - o 8 exploratory research projects with the corresponding grants signed with 29 beneficiaries and linked third-parties, for a total value of EUR 9.9 million, resulting from the open call H2020-SESAR-2016-2 (ER3/VLD Open 1) - o 10 very large-scale demonstration activities for a total grant value of EUR 17.7 million, resulting from the same open call H2020-SESAR-2016-2 (ER3/VLD Open 1) • 1 additional open call for proposals launched in 2017 for very large-scale demonstration activities focusing on Active Geo-fencing Service, under assigned revenue from the European Commission (open call with reference SESAR-2017-1), resulting in one project for a grant value of EUR 0.5 million, • 1 additional open call for proposals launched in 2018, managed under the Connecting Europe Facility (CEF) Programme, focusing on U-space demonstration activities (open call with reference CEF-SESAR-2018-1), resulting in six projects for a total value of EUR 9.4 million • 2 calls for proposals launched in 2019 under the Horizon 2020 programme, resulting in: - o a Wave 2 call, restricted to the SESAR JU Members other than the Union, for industrial research & validation and very large-scale demonstrations (restricted call with reference H2020-SESAR-2019-1). 15 proposals were selected for a total value of EUR 147.2 million and 13 projects were launched into execution before the end of 2019 - o the ER4 call for exploratory research (open call with reference H2020-SESAR-2019-2). 29 proposals were selected for a total value of EUR 37.7 million with signature of the grants planned in the second quarter of 2020 • 2 calls for proposals in 2020 under the Horizon 2020 programme, with award planned before the end of 2020, and corresponding projects taking place until the end of 2022: - o an additional open call on very large-scale demonstration activities (open call with reference H2020-SESAR-2020-1), - o the final Wave 3 call, restricted to the SESAR JU Members other than the Union, for industrial research and validation activities and very large-scale demonstrations (restricted call with reference H2020-SESAR-2020-2)
Procurement management	The overall value of procurement activities in 2019 amounts to EUR 10.4 million, distributed through: • 6 framework contracts, direct services contracts and secondment agreements • 24 specific contracts • 13 amendments

Table 1: The SESAR JU in 2019 in brief

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[22] As some SESAR JU Members are consortia, the 19 SESAR JU Members and Eurocontrol represent in total 39 organisations. There are in addition 80 "linked third-party" organisations in this call for IR and 17 for VLD
[23] See previous footnote

Founding Members

2   Part I. Achievements of the year

This opening section of Part I highlights progress and presents the achievement of the SESAR JU's main objectives in 2019:

1. Provide Strategic Steering to the SESAR Programme,
2. Deliver exploratory research,
3. Deliver industrial research & validation,
4. Deliver very large-scale demonstration Activities,
5. Deliver SESAR Outreach,
6. Deliver effective financial, administrative and corporate management.

All the above-mentioned objectives were achieved in 2019.

The SESAR Joint Undertaking, setting out a vision for the future of air traffic management in Europe

The SESAR JU provides technical support to the Commission on the technological pillar of the Single European Sky; in that role, the SESAR JU:

- submitted to the Commission the results of a study on the future architecture of the European airspace (under a fourth regulatory framework), articulating with the other pillars of the SES such as the Network Manager and the performance scheme,

- led the update campaign of the European ATM Master Plan. Further information on these activities is available in Section 2.1.

Furthermore, under the coordination of the European Commission, the SESAR JU is responsible for cooperation with ATM stakeholders at the regional and international levels, and for communication and dissemination of ATM research-related information. Further information on these activities is available in Section 2.5.

Overview of calls and grants up to 2019

At the end of 2019, the SESAR 2020 programme covers the full SESAR innovation pipeline through seven calls for proposals under three different legal frameworks:

- under the Horizon 2020 programme:

  o the first exploratory research open call for proposals H2020-SESAR-2015-1 (ER1) resulting in 28 projects for a total maximum EU funding of EUR 20.4 million; all ER1 projects were completed and closed in 2019;

  o the first call for proposals H2020-SESAR-2015-2 (IR-VLD Wave 1), restricted to the 20 SESAR JU Members other than the Union (Eurocontrol and 19 other SESAR JU stakeholder Members) resulting in 20 industrial research and validation projects (of which three dedicated to Transversal Steering Activities) for a total maximum EU funding of EUR 206.7 million, and in five (1 was terminated in 2017) very large-scale demonstration projects for a total maximum EU funding of EUR 31.7 million;

- o the second exploratory research open call for proposals H2020-SESAR-2016-1 (ER2-RPAS) resulting in nine projects for a total maximum EU funding of EUR 8.3 million;

- o The third exploratory research open call for proposals launched within the call with reference H2020-SESAR-2016-2 (ER3) resulting in eight projects for a total maximum EU funding of EUR 9.9 million; this call was combined with the first very large-scale demonstration open call for proposals (VLD Open 1) resulting in ten projects for a total maximum EU funding of EUR 17.7 million. The second call for proposals H2020-SESAR-2019-1 (IR-VLD Wave 2), restricted to the 20 SESAR JU members other than the Union (Eurocontrol and 19 other SESAR JU stakeholder members) resulting in twelve industrial research and validation projects (of which two dedicated to Transversal Steering Activities) for a total maximum EU funding of EUR 130.5 million (EUR 84.2 million allocated to the first instalment in 2019, the second instalment will take place in 2020), and in three very large-scale demonstration projects (one grant signed in 2019 and two grant agreements still under preparation for a total maximum EU funding of EUR 16.7 million (EUR 10.8 million allocated to the first instalment in 2019, the second instalment will take place in 2020);

- under assigned revenue from the European Commission: the second very large-scale demonstration open call for proposals SESAR-2017-1 for very large-scale demonstration activities focusing on Active Geo-fencing Service, resulting in one project for a total maximum EU funding of EUR 497 403;

- under the Connecting Europe Facility (CEF) Programme: the third very large-scale demonstration open call for proposals CEF-SESAR-2018-1, focusing on U-space demonstration activities and resulting in six projects for a total maximum EU funding of EUR 9.4 million.

These seven calls for proposals have thus resulted, at the end of 2019, in a total of 100 projects[24] covering the full spectrum of the research topics defined in the SESAR 2020 Multi-Annual Work Programme:
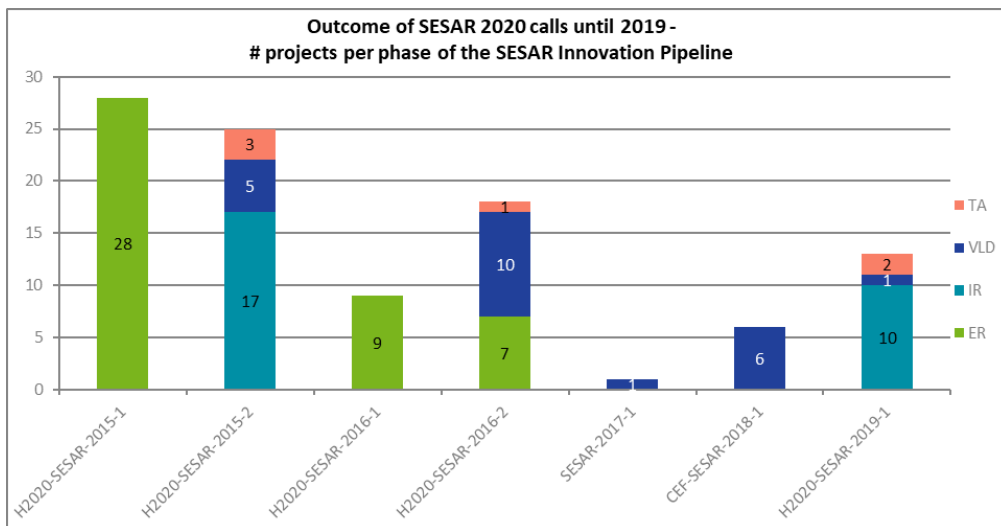
Figure 4: Number of projects per phase of the SESAR Innovation pipeline, per call (end 2019)

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[24] At the end of 2018, 86 projects were reported, and 14 were launched into execution in the course of 2019 (1 resulting from the ER3 call with reference H2020-SESAR-2016-2 and 13 resulting from the IR-VLD Wave 2 call with reference H2020-SESAR-2019-1)

The SESAR 2020 programme portfolio of projects resulting from these calls is structured according to the topics defined in the SESAR 2020 Multi-Annual Work Programme, as follows:
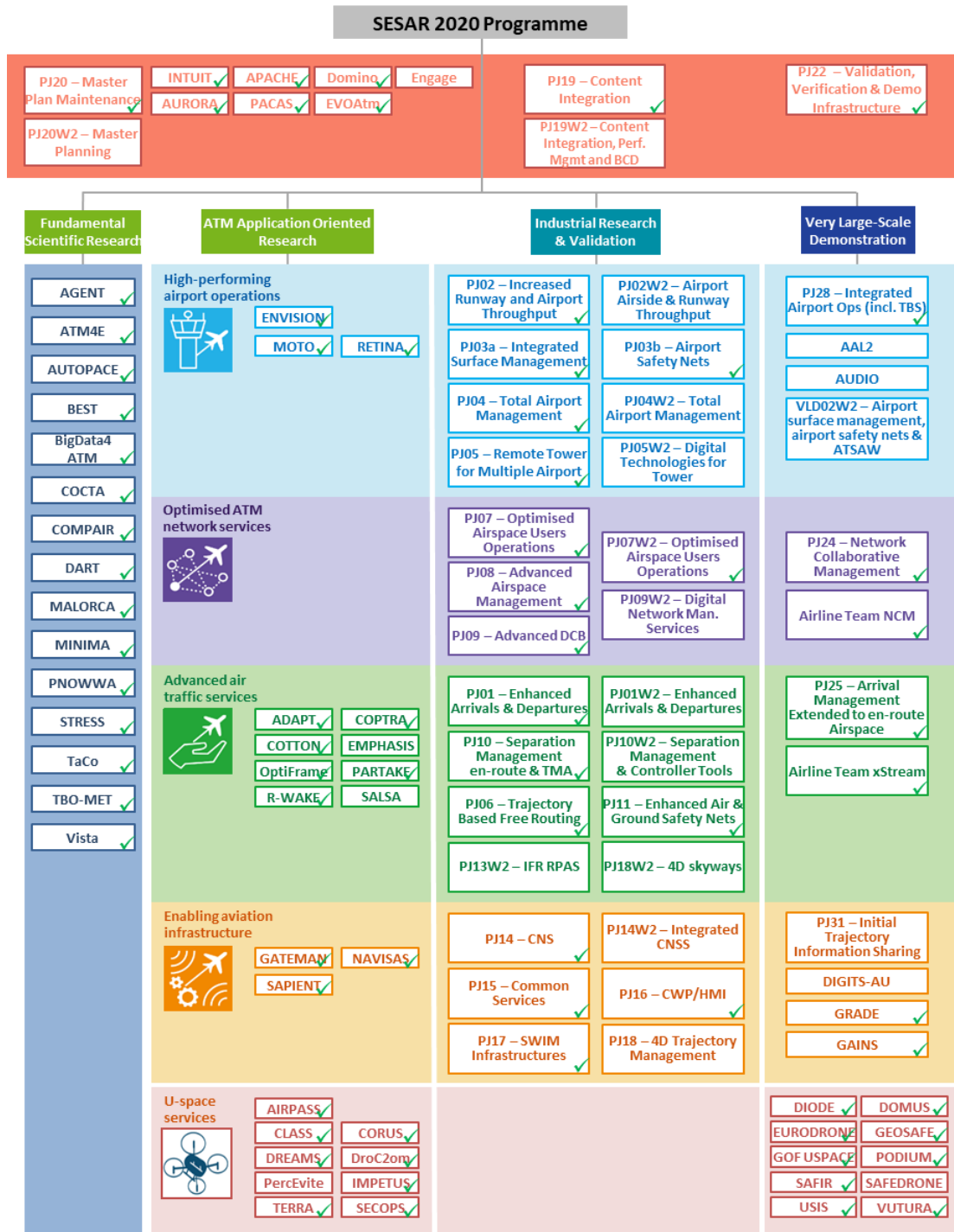
Figure 5: The SESAR 2020 programme portfolio of projects matching the research topics at the end of 2019 (projects in execution or closed)[25]

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[25] The figure shows 99 projects in execution or closed as one project resulting from the call for proposal IR-VLD Wave 1 with reference H2020-SESAR-2015-2 was terminated

At the end of 2019, three additional calls for proposals were in grant agreement preparation phase or planned and under preparation for launch in 2020, which will be the last year for commitments under Horizon 2020.

In total, up to 2019, the SESAR JU has successfully awarded grants for a total cumulated value of more than EUR 387.3 million, which represents almost 75% of the overall objective of funding of SESAR 2020. As initially planned in the SESAR 2020 Multi-Annual Work Programme, and with the inclusion of assigned revenues later on, the funding of activities through restricted and open calls for proposals will continue over the coming years with a forecasted cumulated amount of more than EUR 525.7 million by the end of 2020, as depicted in the graph below (dates refer to the grant award):
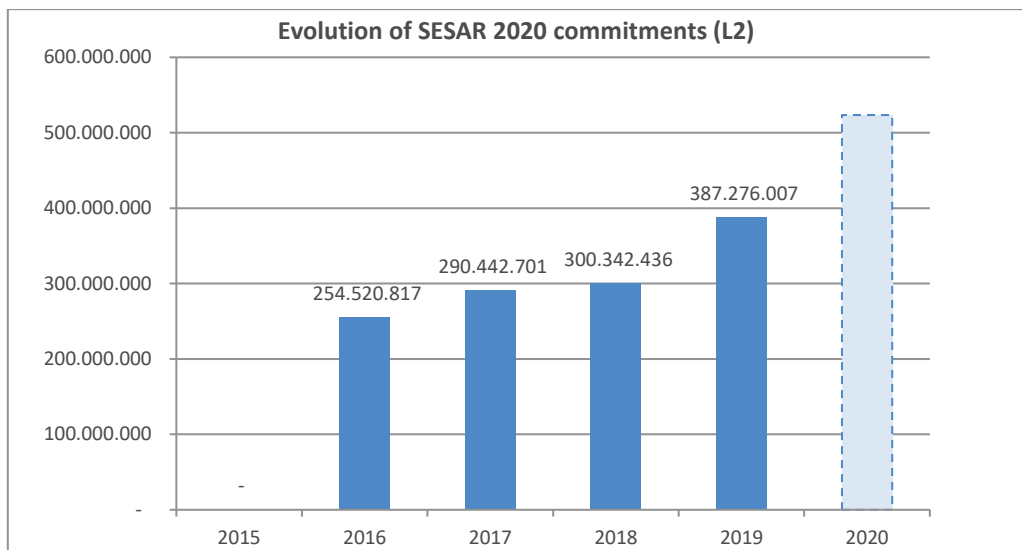
Figure 6: Evolution of SESAR 2020 call-related commitments (EUR), forecast for 2020 in dashed column

Figure 6 shows that the SESAR JU invests 90% of its overall EU contribution (EUR 596.3 million) in research and innovation projects resulting from calls for proposals under H2020, CEF and other frameworks[26], the rest being allocated to the procurement of services and studies in relation with core operations (covered from a budgetary perspective in the Title III – Operational expenditure) and to

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[26] Besides the EU contribution of EUR 585 million established under the Horizon 2020 programme, additional EU contribution of EUR 11,3 million was provided to the SESAR JU by the European Commission under three delegation agreements through which the SESAR JU was mandated to carry out additional activities in the area of air traffic management.
These delegation agreements are the following:
- delegation agreement EC/SESAR JU (ref. MOVE/E3/DA/2016-669/SI2.743803) signed on 6 December 2016, with a delegated budget of EUR 500.000 in assigned revenue to organise a call for proposals for a geo-fencing demonstration, in accordance with Articles 54(2)(a) and 58(1)(c)(iv) of the Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council of 18 July 2018 on the financial rules applicable to the general budget of the Union (EU Financial Regulation) (OJ L 193, 30.7.2018, p. 1)
- delegation agreement EC/SESAR JU ref. MOVE/E3/DA/2017-477/SI2.766828 signed on 10 November 2017, with a delegated budget of EUR 800.000 in assigned revenue to procure a study to develop a proposal for the future architecture of European airspace,
- delegation agreement EC/SESAR JU ref. MOVE/E3/DA/2017-564/si2.771010 signed on 13 December 2016, with a delegated budget of EUR 10 million in assigned revenue from the CEF funds to organise a call for proposals on U-space demonstrations.

Founding Members

running costs (covered from a budgetary perspective in the Titles I – Staff expenditure and II – Infrastructure and operating expenditure).

Further information on the calls for proposals, their outcomes and the resulting projects is available in Sections 2.1 to 2.4 below.

A programme benefitting to a broad range of stakeholders

Beneficiaries and linked third-parties of the SESAR 2020 calls for proposals represent all types of organisations targeted by Horizon 2020:
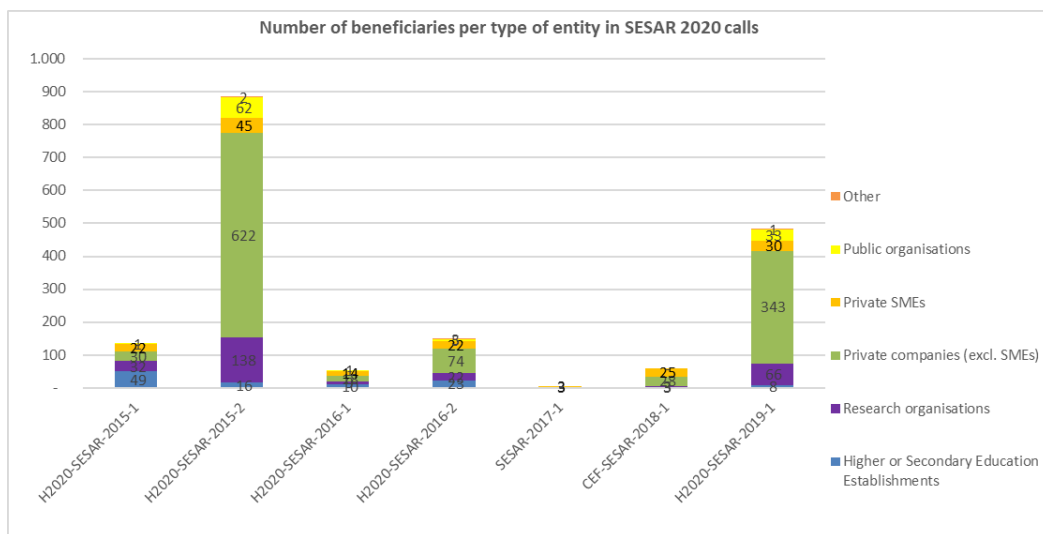
Figure 7: All types of organisations are beneficiaries of SESAR 2020 funding

This funding is distributed across 27 EU Member States:

EU Member States with SESAR 2020 funding
EU Member States with participant having the Coordinator role
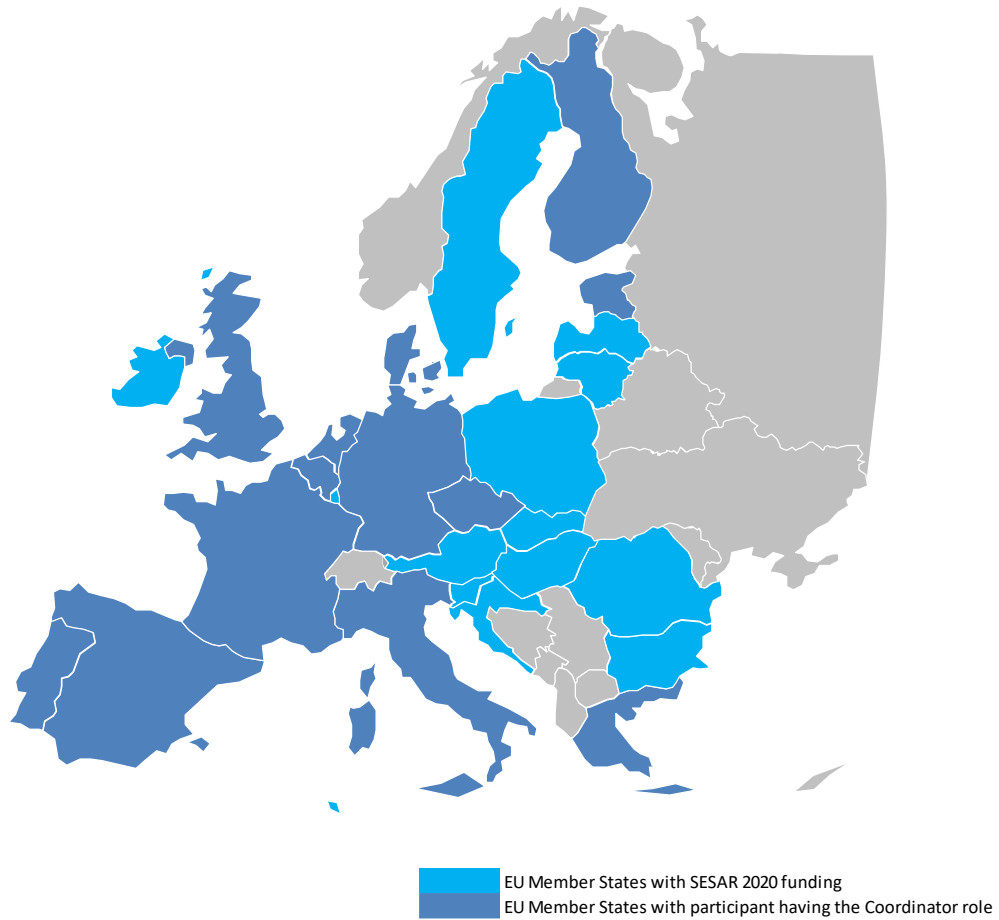
Figure 8: SESAR 2020 funding for EU Member States at the end of 2019

The delivery of candidate SESAR Solutions progressed significantly in 2019…

The funded IR projects are delivering results in the form of candidate SESAR Solutions, which, through the release process, are validated at a certain maturity level (V1 or TRL2, V2 or TRL-4, V3 or TRL-6, the latter corresponding to readiness for industrialisation and further deployment). Releases are delivered every year. Figure 9 shows the number of (candidate) SESAR Solutions delivered through the Releases in action in 2019, namely Release 8 (concluding in April 2019), Release 9 (delivering in 2019 and planned to conclude in April 2020), and Release 10 (the plan of which was in preparation during 2019):

Founding Members

EUROPEAN UNION   EUROCONTROL
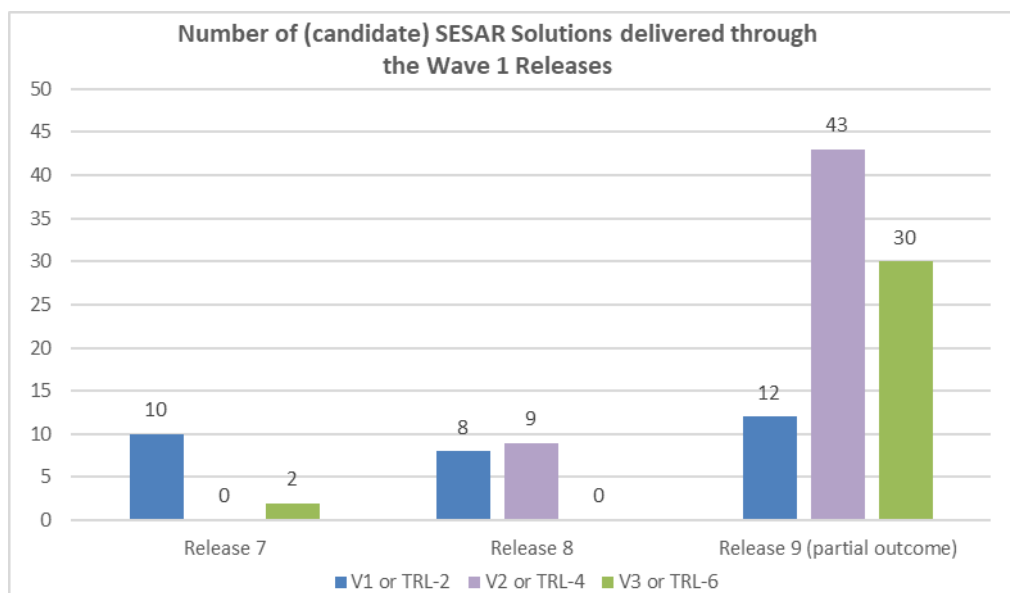
Figure 9: Number of (candidate) SESAR Solutions delivered through Releases 7, 8 and 9 (at the end of 2019)

The figure above shows that the delivery of SESAR Solutions is effective. This is expected to continue in the coming years, with for instance some solutions in V2 or TRL-4 level of maturity being further developed and delivered through the subsequent releases up to 2022 under Wave 2 and Wave 3.

… thus enabling to secure a contribution to the Master Plan performance ambitions

Therefore, the SESAR 2020 programme has already delivered effective contribution to the performance ambitions as set in the 2015 edition of the European ATM Master Plan.

As the technological pillar of the Single European Sky (SES), SESAR is one of the key contributors to achieve high-level goals (HLGs) in the areas of Safety, Capacity, Environment and Cost-efficiency, as introduced in paragraph 1.2 above. Not only does SESAR support these SES HLGs but also aims at enabling additional performance ambitions, as stated in the European ATM Master Plan, through the full implementation of the SESAR vision within the 2035 timeframe. In this regard, SESAR performance ambitions are aspirational and refer to the performance capability that may be achieved if SESAR Solutions are delivered and deployed at the European Civil Aviation Conference (ECAC) level[27] in a timely and, when needed, synchronised way, and used to their full potential.

However, it is worth noting that the performance ambitions reported in the ATM Master Plan (2015 edition) should not be allocated to SESAR alone since other actors, notably air navigation service providers (ANSPs), States, civil and military airspace users are also expected to actively contribute towards their achievement. While the ATM Master Plan does not provide a clear indication on the contribution expected from SESAR, with the exception of cost-efficiency, SESAR is fully committed to achieving the high-end values of the expected ranges.

The SESAR JU has designed a performance management process to measure performance against the ambitions recorded in the Master Plan, which are translated into key performance areas (KPAs) and the related measurable indicators - key performance indicators (KPIs). However, SESAR KPIs are not

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[27] The scope of the SESAR's performance ambitions cover all flights in the ECAC area (except IFR flights at congested airports), within a 2035 timeframe and relative to the 2012 baseline.

always equivalent to those described in the Master Plan due to the nature of the SESAR research and innovation programme. The SESAR performance framework aims at capturing these differences and providing a bridge between ATM Master Plan ambitions and solution assessments.

The SESAR performance ambitions must be reconciled with the operational improvements expected by individual solutions hence, specific quantitative validation targets are allocated to each SESAR Solution. Validation targets are defined as the overall contribution that solutions should make to the achievement of the performance ambitions set in the ATM Master Plan.

The next step is to evaluate the performance benefits and costs of the operational improvements for each solution through validation exercises and dedicated analysis. This involves assessing the evaluated level of performance against the validation targets allocated to each solution.

The performance assessment per solution is refined as the solution evolves in its maturity level as per lifecycle V-phase[28]:

- V0/TRL0: identification of potential benefits and risks;

- V1/TRL2: potential benefit and impact mechanisms and influencing factors with an initial assessment on the relevant KPIs;

- V2/TRL4: quantitative intermediate assessment on all relevant KPIs;

- V3/TRL6: complete assessment including final quantitative results on all relevant KPIs.

Performance benefits are then monetised and analysed in the form of a cost-benefit analysis (CBA), providing key measures on expected costs and benefits for key stakeholders should they invest in a specific SESAR Solution.

Each SESAR Solution has to be considered from an ECAC-wide perspective, extrapolating the expected performance at ECAC level in their performance assessment reports (PARs). The results from solutions are then consolidated taking into account different deployment scenarios and the relationship between solutions to obtain a consolidated view of the expected combined performance.

The outcome of this process is the delivery of a yearly Performance Assessment and Gap Analysis Report (PAGAR), which covers the following transversal areas (safety, security, human performance, environment, capacity, predictability, punctuality, civil-military coordination and cooperation, flexibility and cost-efficiency). The PAGAR is used to identify the related validation target gaps and identify new research and innovation needs, which are fed back into the Master Plan.

The figure below provides, for each KPI, an overview of the expected performance results delivered by SESAR R&D activities compared to the performance ambitions stemming from the Master Plan. The assessment only refers to IR results and excludes any benefits stemming from Very Large demonstrations (VLDs).

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[28] The maturity assessment consists of checking whether or not the set of SESAR maturity criteria for a given V / TRL maturity Phase for a SESAR Solution under analysis are successfully documented.
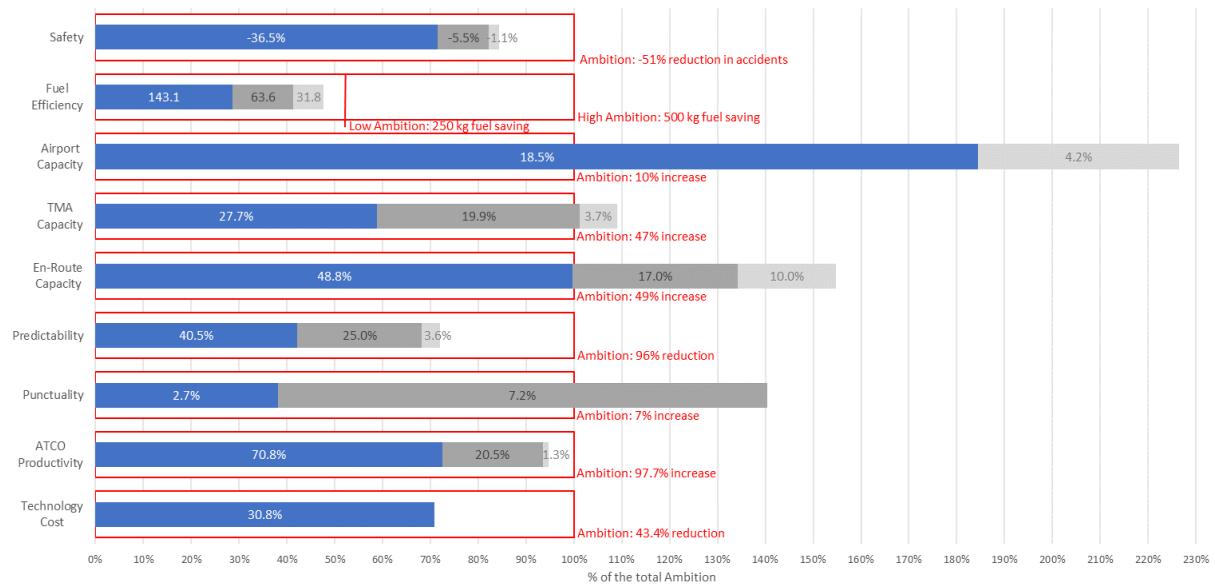
Figure 9: Planned SESAR cumulated research and innovation contribution to the realisation of the ATM Master Plan KPAs

In this figure:

- blue bars indicate the expected performance benefits stemming from deployment baseline and non-SESAR activities together with benefits from solutions that reach V3 maturity level in SESAR 1 and SESAR 2020,

- dark grey bars indicate additional performance benefits stemming from solutions, the 'V3' delivery of which is expected in the next phase of the programme (i.e. solutions that would have reached V1 or V2 level of maturity at the end of the SESAR 2020 programme),

- light grey bars show the potential gains that might be achieved if those candidate solutions ended in Wave 1 would have been continued and reached their full maturity in Wave 2[29].

The figure above shows that for most of the key performance areas, the level of expected performance allowed at the end of the SESAR 2020 research and innovation programme should reach the performance ambition levels in particular with the additional benefits that will be brought by the Wave 2 and Wave 3 validation activities.

With the progress already achieved up to 2019, with the ongoing delivery of candidate SESAR Solutions and based on the result of estimated performance results stemming from actual V1 activities, the SESAR JU is confident that the SESAR 2020 programme will provide the required research and innovation contribution to achieve the targeted improvement of the European ATM system.

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[29] These solutions were discontinued in Wave 2 following a prioritisation activity performed during the Wave 2 preparation phase (see the SESAR JU's CAAR for year 2018, Subsection 2.3.3) and as a consequence of the limited budget available. Nevertheless, even for those solutions not continuing in Wave 2, full data packs are available for any entity wishing to further exploit potential performance benefits in the future.

Preparing for the future

In 2019, not only did the SESAR JU deliver results to fulfil its objectives towards the achievement of the ambition levels set in the ATM Master Plan (edition 2015), but it also carried out major activities in relation with the future development of European ATM within the overall EU transport policy and strategy. The Airspace Architecture Study presented a new approach to Europe's airspace architecture that leverages modern technologies and decouples service provision from local infrastructure. It was followed by the Transition Plan setting out three key operational and technical measures to be put in place in the short term (i.e. in the period from 2020 to 2025) in order to set in motion the transformation changes outlined in the Study. The European ATM Master Plan (2020 edition) sets the direction for the delivery of the Digital European Sky enabling it to handle the future growth and diversity of air traffic safely and efficiently, while establishing European as the most environmentally friendly sky to fly in the world.

The SESAR JU is confident that an extension of the Programme in the future will provide the required research and innovation contribution to achieve the expected improvement of the European ATM system, supporting the renewed ambition and high-level objectives pursued by the European Union on environment (in particular, the "European Green Deal"), digitalisation and smart mobility.

All the achievements of the SESAR JU in 2019, summarised in the paragraphs above, are described in further detail in the following sections within this Part.

Founding Members

EUROPEAN UNION   EUROCONTROL

2.1 Strategic Area of Operation 1: Provide Strategic Steering to the SESAR Programme

The SESAR JU met all its objectives related to Strategic Steering of the SESAR programme in 2019. This includes the following achievements and results:

- *Call reference H2020-SESAR-2015-2 (IR-VLD Wave 1 call for proposals) – Wave 1 Transversal Activities projects delivery of results: projects PJ.19, PJ.20 and PJ.22 were in execution and completed the delivery of their expected contributions on Performance, Architecture and Master Plan update. They were formally closed at the end of 2019 (see Subsection 2.1.3)*

- *Call with reference H2020-SESAR-2019-1 (IR-VLD Wave 2 call for proposals) – launch, evaluation and award of the Transversal Activities: projects PJ.19-W2 and PJ.20-W2 were launched into execution on the 1st December 2019 selected as a result of the Wave 2 evaluation process and successful grant agreement preparation process (see Subsection 2.3.2.1)*

- *Strengthen coordination with relevant Master Plan stakeholders: the European ATM Master Plan was delivered in April 2019, submitted to the European Commission for a wide consultation process, and eventually adopted by the SESAR JU Administrative Board following that consultation process on the 17 December 2019 (see Subsection 2.1.2)*

- *Continued coherence between all three levels of the Master Plan: following the adoption of the 2020 edition of the European ATM Master Plan in December 2019, instruction was given to the SESAR JU to proceed with the alignment of the three levels of the Master Plan (see PJ.20 AMPLE in Subsection 2.1.3)*

- *Development of a transition plan for implementing the recommendations of the Airspace Architecture Study: the "Future architecture of the European airspace – Transition plan" (AAS-TP) was delivered on 4 October 2019 (see Subsection 2.1.1.1.3)*

- *Provide support to European Commission on other areas linked to the technological pillar of the SES: this objective was delivered through the Airspace Architecture Study and its Transition Plan (see Subsection 2.1.1)*

- *Ensure effective and efficient SESAR 2020 programme governance meetings: the SESAR JU held three meetings with the Scientific Committee, four meetings with the Programme Committee and three meetings with the Master Planning Committee. These three advisory bodies provided support to the SESAR JU Executive Director in steering the operational activities of the SESAR JU, through a number of contributions in the form of strategic document reviews, participation in evaluation activities, etc. (see Subsection 2.1.4)*

The delivery of the Airspace Architecture Study and its Transition Plan and the adoption of the 2020 edition of the European ATM Master Plan represent key achievements in SESAR JU's support to the European Commission in steering the SESAR programme.

2.1.1   The Airspace Architecture study

The proposal for the future European airspace architecture embraces a new era of innovation and digital technologies in consistency with the Single European Sky initiative, the European Aviation Strategy and the European ATM Master Plan. It was developed in 2018 and formally handed over to the Commission on 5 February 2019. The activities carried out in 2019 for the implementation of the Delegation are thus in continuation of the activities carried out in 2018, which have been described in the SESAR JU's CAAR for 2018.

2.1.1.1   Operational implementation of the entrusted task in 2019

The study developed concrete proposals towards an optimised airspace architecture, aiming at enabling more efficient traffic flows and promoting an optimised provision of air navigation services together with the enabling ATM/CNS infrastructure. It also aimed at fully responding to the needs of the airspace users in a context of capacity challenges and long-term traffic growth forecast. Whilst referring as requested on the concept of European Upper Information Region (EUIR), the study instead developed building on the more innovative concepts of cross-border Free Route Airspace (FRA), dynamic cross-border air navigation service provision, and flight-centric operations and their related enablers.

In a nutshell, the study set the SESAR JU and Network Manager vision on how the European airspace architecture should look like in the medium to long term (2035), describing the intended airspace organisation, design and operations and the steps to be taken to achieve that architecture. It was largely welcomed in principle by the aviation community and European Commission, and was reflected in the recommendations of the Wise Persons Group on the future of the Single European Sky.

Having successfully carried out and closed the tasks planned under the delegation agreement, the SESAR JU was asked to secure and confirm convergence between the study's recommendations and the Master Plan which was being updated in parallel. It also received on 16 April 2019[30] an additional request from the Commission to expand work under this delegation agreement and develop a transition plan regarding the operational and technical dimensions of the target architecture defined in the AAS. The transition plan was requested to contain short-term and longer-term actions, as well as ideas for the implementation of the operational and technical changes. It was also acknowledged that the framework comprising the regulatory and service delivery models was to be addressed in parallel by the Commission.

This document reports on 2019 only, and therefore focuses on:

- the finalisation and transmission of the airspace architecture study to the Commission (Q1 2019);
- the convergence between the Airspace Architecture Study and the Master Plan update campaign (Q2 and Q3 2019);
- the development and transmission of the AAS transition plan to the Commission (Q2 and Q3 2019).

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[30] Letter from Director Aviation MOVE.DDG2.E/GM-hb Ares (2019) 2945582.

2.1.1.1.1 Finalisation and transmission of the airspace architecture study to the Commission

Following a full year of work in 2018 involving intense stakeholder consultation through workshops, bilateral meetings and the delivery of a draft final report in November 2018[31], the first weeks of 2019 were devoted to the finalisation of the study, taking on board last comments received, including from the Commission, and more particularly the drafting of the regulatory part in Section 6.2 and Annex F on the regulatory approach.

This work on the regulatory aspects was based on the preliminary findings of the study and was carried out by the SESAR JU with the support of a legal consultants ad-hoc consortium. Their input was twofold:

1. a legal and regulatory analysis of each scenario developed in the airspace architecture study, assessing its legal and regulatory aspects including feasibility of implementation, as well as all possible impediments to overcome through adequate legislative and/or regulatory evolution to realise the policy objectives of the SES;

2. an analysis of the possible models of service provision for each scenario, including the possibility to open service provision to competition for or in the market.

These elements provided the basis for the drafting by the SESAR JU of the regulatory part of the study and the associated Annex in January 2019. This final work allowed the delivery of the study to the European Commission on 5 February 2019 and its presentation at the event organised on 5 March 2019 by the Sky and Space Intergroup of the European Parliament.

This materialised the completion of the work requested under Delegation Agreement MOVE/E3/DA/2017-477/SI2.766828.

2.1.1.1.2 Convergence between the Airspace Architecture Study and the Master Plan update campaign

The Airspace Architecture Study (AAS) was developed in full synchronisation with the European ATM Master Plan update campaign (see below in 2.1.2), which took place mainly in 2018 but was put on hold for a few months in 2019, precisely to allow incorporating the main recommendations from the AAS, as requested by the Commission. This was done by the SESAR JU in Q1 2019, allowing a first complete Master Plan draft, incorporating the relevant AAS findings, to be delivered to the Commission and SESAR JU Administrative Board members on 12 April 2019, thus triggering the opening of the formal consultation period. As a result of this consultation, which included the Single Sky Committee and Eurocontrol's Provisional Council, the Master Plan document was further refined, and formally adopted by the SESAR JU Administrative Board on 17 December 2019.

The adopted Master Plan Edition 2020 now fully demonstrates that the SESAR 2020 programme is set up to support the AAS recommendations should they be implemented.

2.1.1.1.3 Additional work beyond the Delegation Agreement: development and transmission of an AAS transition plan

Following the successful completion of the entrusted task and the relevant convergence with the Master Plan, the SESAR JU received on 16 April 2019[32] an additional Commission request to expand work and develop, as rapidly as possible and in close cooperation with the Network Manager, a

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[31] Described in detail in the SESAR JU's Consolidated Annual Activity Report for year 2018.
[32] Letter from Director Aviation MOVE.DDG2.E/GM-hb Ares (2019) 2945582

transition plan regarding the operational and technical dimensions of the target architecture defined in the AAS.

The plan was requested to contain short-term and longer-term actions, as well as ideas for the implementation of the operational and technical changes. It was also acknowledged that the framework comprising the regulatory and service delivery models was to be addressed in parallel by the Commission.

The approach of the transition plan was to focus and zoom into the "operational and technical dimensions" subset of the AAS Transition Strategy, as depicted in the figure below:
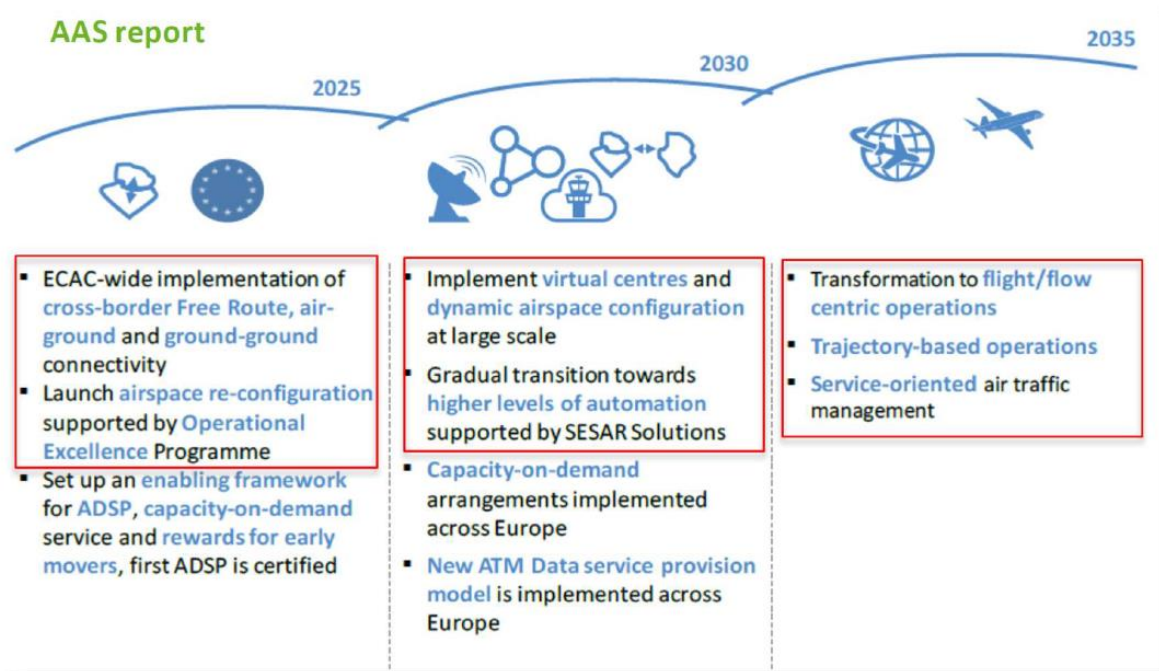
Figure 10: The approach to the Airspace Architecture Study transition plan: focusing on operational and technical aspects (in red boxes) of the AAS high-level transition strategy

The deadline for carrying out the work was 1 September 2019, in view of a presentation at the High Level Conference on the Future of the Single European Sky organised by the European Commission on 12 September 2019. Less than five months, including the summer break, were therefore allowed to carry out and deliver this work.

In view of the worsening of the capacity situation and the fast-growing flight delays affecting the European network, the Commission added a strong sense of urgency to move towards the implementation of the AAS and asked to focus on the actions and programmes that aim at bringing the proposed AAS transition strategy into motion, with a focus on short term solutions to the capacity crunch.

For this reason, the transition plan focused on three key operational and technical measures that need to be implemented in the very short term (2020 to 2025) in order to set in motion the transformation changes outlined in the AAS. These 3 measures were:

- The launch of an airspace re-configuration programme supported by an operational excellence programme to achieve quick wins (target deadline: 2025);

- The implementation of the planned roll-out related to mature SESAR Solutions supporting the implementation of cross border free route, and air-ground and ground-ground connectivity (target deadline: 2025);

- The acceleration of market uptake of the next generation SESAR technologies and services in order to prepare the de-fragmentation of Europe's skies through virtualisation and the free flow of data among trusted users across borders (target deadline: 2025, to allow delivering the technology required to implement the functionalities needed by the milestones 2030 and 2035 as described in this high-level transition strategy).

The activities were kicked off on 13 May 2019 with the approval by the SESAR JU Executive Director of the relevant work plan jointly designed by the SESAR JU, Network Manager and Eurocontrol teams. The work plan described the main objectives, tasks and how the SESAR JU structured the work that resulted in the delivery of a proposal by end September 2019. Concretely, a draft was delivered on time for presentation on 12 September, then the SESAR JU collected and integrated comments and delivered the final document on 4 October 2019.

The study was executed by the SESAR JU in close cooperation with the Network Manager and Eurocontrol. Stakeholders were associated at high level all along work on the study through the established SESAR JU governance (the Master Planning Committee for strategic guidance), and the Network Manager governance (the Network Management Board, to secure full alignment between the Transition Plan and the Network Strategy Plan).

To carry out the work, because of the very short time allocated, a reduced and agile team was constituted to secure timely progress of work and expert stakeholder involvement. It was composed of:

- A Content Integration Team (with weekly touch-point meetings), composed of:

  o a SESAR JU coordinator;

  o a Eurocontrol focal point;

  o a Network Manager focal point.

  The European Commission (DG MOVE) was invited to designate also a focal point to contribute to the monitoring, oversight and steering of work but it had to decline because of lack of time and resources.

- An Airspace Architecture Study – Transition Plan Team (AAS-TP T): this team was composed of the SESAR JU (chairing), supported as necessary by the Network Manager and Eurocontrol. Participants were designated by the Members of the Master Planning Committee, thus representing all stakeholder categories as well as the key European aviation institutions, namely:

  o ANSPs,

  o airspace users,

  o professional staff associations,

  o airports,

  o the ground and airborne manufacturing industry,

  o the European Aviation Safety Agency (EASA),

  o the European Defence Agency (EDA),

  o the SESAR Deployment Manager,

- o the European Organisation for Civil Aviation Equipment (EUROCAE) ;

- The team held a kick-off web conference in May 2019 and three meetings on 23 May, 19 June and 3 July 2019.

- It reviewed and advised on the different versions of the proposal through its various levels of maturity, starting from a "strawman" and evolving towards a mature draft.

In addition to the meetings of the AAS-TP T and the consultation of the Master Planning Committee and Network Management Board, to secure advanced buy-in and "de-risk" possible disagreement points that may jeopardise timely conclusion and transmission to the EC, the SESAR JU conducted a number of informal bilateral meetings with air navigation service providers (CANSO), airspace users (A4E and IATA), airports (ACI), NSAs (through the usual Quarterly meetings), industry (Thales and Airbus), aiming at representing the widest possible representation of interested parties:

The Work Plan established four tasks to carry out:

1. Update the Master Plan Level 3: The task consisted in delivering an updated proposal for the ATM Master Plan Level 3 implementation plan to cover the AAS transition strategy.

2. Identify the changes needed to other relevant plans supporting the execution of the European ATM Master Plan: and in particular:

   o the Network Strategy Plan (version 2020-2029);

   o the Deployment Programme (version 2018);

   o the EASA European Plan for Aviation Safety (version 2019-2023);

   o the EASCG European standards rolling development plan (version V8).

3. Propose Terms of Reference to implement Recommendation 1 of AAS identifying the need to launch two programmes, 1) An EU-wide airspace re-configuration programme and 2) an EU-wide operational excellence programme. This task was led by the Network Manager.

4. Consolidation into a final report to the Commission.

The preparation of the transition plan was executed in three phases, as follows:

1. **Phase one** (from May to end of June) core development work, covering all four tasks,

2. **Phase two** (from mid-June to the end of July) preliminary results shared through the SESAR JU, Eurocontrol and Network Manager governance in view of finalising work,

3. **Phase three** (August to 12 September) overall refinement of the proposed transition plan leading up to the presentation of the results at the conference.

The final report was submitted to the Commission on 3 October 2019, with three annexes:

- Description of update proposal for MP Level 3,

- Changes needed to other existing plans (NSP, DP, EPAS, rolling standards development plan),

- Terms of reference for the programmes of airspace reorganisation and operational excellence.

2.1.1.2   Communication activities in relation with the entrusted task in 2019

In 2019, the SESAR JU promoted the study through a range of activities and communications channels:

Events

The Airspace Architecture Study was presented at many events and meetings throughout 2019, most notable among them were:

- European Parliament workshop on Airspace Architecture Study, 5 March, Brussels – read article,
- World ATM Congress, 10-12 March 2019, Madrid,
- Digital European Sky – High Level Conference on the Future of the Single European Sky, 12 September, Brussels,
- Presentation by Florian Guillermet at AVIA Group European Council, 5 September, Brussels.

Publication

The study was printed and distributed at several large events (see above). It is also available on the SESAR JU website:

- Printing of Airspace Architecture Study,
- Printing of Airspace Architecture Study – Transition Plan,

News and articles

- Airspace Architecture Study presented at European Parliament,
- Plan offers way forward on airspace modernisation,
- A plan for its times.

Twitter and LinkedIn

The promotion of the study was also covered in social media (see examples):

- https://twitter.com/Bulc_EU/status/1103208533217153024,
- https://twitter.com/SESAR_JU/status/1172105816847060993,
- https://twitter.com/SESAR_JU/status/1105464405783969793,
- https://twitter.com/SESAR_JU/status/1102974448796340224.

2.1.1.3   Audit activities

The SESAR JU has the obligation under Article 21 of the Delegation Agreement for the AAS with DG MOVE (MOVE/E3/DA/2017-477/SI2.766828), to provide annually to DG MOVE an opinion of an independent audit body, in accordance with internationally accepted audit standards, establishing whether for this expenditure:

- the accounts give a true and fair view;
- the control systems put in place function properly;
- the underlying transactions are legal and regular;
- the audit work puts in doubt the assertions made in the management declaration.

The SESAR JU in the framework of its annual audit on the SESAR JU accounts, has requested to the European Court of Auditors, as an independent audit body, to provide an opinion on this dossier in

accordance with the delegation agreement. The ECA has included a sample from this expenditure in their audit work for the financial year 2018. The opinion transmitted by the European Court of Auditors to the SESAR JU on this sample on the 23 October 2019 is *that "the audit of this payment transactions did not reveal any financial and compliance errors."* With this opinion of the Court, the SESAR JU understands that it is compliant with its obligations under the delegation agreement.

2.1.2 Final update to the European Master Plan and release of the 2020 edition

Work on the Master Plan had been launched at the end of 2017, during the Digital Transport Days in Tallinn of November 2017. The update campaign covered the entire year 2018, reaching by the end of the year a good level of maturity. However, it was put on hold temporarily in Q1 2019, to allow connecting with the main recommendations from the AAS, which was carried out in parallel and delivered to the Commission on 5 February 2019. This convergence work was carried out by the SESAR JU in Q1 2019, allowing a first complete Master Plan draft to be delivered to the Commission and SESAR JU Administrative Board members in April 2019, thus triggering the opening the formal consultation period. As an outcome of this consultation, the Master Plan document was further refined and formally adopted by the SESAR JU Administrative Board on 17 December 2019.

The adopted Master Plan Edition 2020 is widely acknowledged as a key structuring document that:

- provides a clear vision for the finalisation of the SESAR project, towards a "digital European sky" based on interoperable and more automated systems allowing smooth data exchange and "capacity-on-demand";

- re-prioritises actions to address capacity shortage, in particular through combining operational improvements and technological solutions (Airspace Architecture Study). It fully demonstrates that the SESAR 2020 programme is set up to support the AAS recommendations should they be implemented;

- addresses integration of all air vehicles, manned and unmanned, civil and military, in all airspaces, controlled or not (first reference to U-space);

- contains tools to accelerate SESAR market uptake;

- reflects the human dimension and acknowledges the change needed in a more automated environment;

- is synchronised with EASA's European Plan for Aviation Safety (EPAS).

2.1.3 Contributions from the transversal steering projects

Three projects delivered results related to the transversal steering of the SESAR 2020 programme: PJ.19 'Content Integration', PJ.20 'Master Plan Maintenance' and PJ.22 'Validation, Verification and Demonstration infrastructure'. The following paragraphs outline their achievements in 2019.

PJ.19 or **the Content Integration project** completed its three years cycle at the end of 2019. The overall mission of this project was to **ensure consistency & coherency of the future European ATM System and to report overall and aggregated** performance results as delivered by all industrial research projects. Its key achievements are of different nature and could be summarised as follows:

- achievements referring to the improvement of the quality of the content produced by the SESAR Solutions; and its consistency and coherency at programme level;

- achievements in starting to address cyber security within ATM, primarily to deliver 'securable and resilient' SESAR Solutions, with the set-up of a dedicated group of experts working at transversal level providing a common risk security assessment method, and permanent support and coaching to the SESAR Solutions.

- achievements referring to the improvement of the SESAR Solution validation activities monitoring with the development of several dashboards (performance, architecture, cyber security) used on a daily basis to anticipate as much as possible the issue and/or difficulties SESAR Solutions were facing to; and to a pro-active role:

  o to support SESAR Solutions to prepare the Maturity Gates;

  o to support SESAR JU in the SESAR 2020 Work Programme execution and

  o to support the European ATM Master Plan 2019 update campaign.

In addition to a large number of supporting activities helping SESAR JU and industrial research projects, the above achievements are also reflected in the deliveries done in the course of 2019, namely:

- The **SESAR Concept of Operation – CONOPS describing** the future Air Traffic Management (ATM) operations envisaged in Europe. The objective is to provide a high-level view of the operational characteristics of ATM in the future European airspace coming from the development of the SESAR Programme, and the main significant changes they imply in operating practices along with the capabilities they require. It is fully aligned with the ATM Vision defined for the 2020 edition of the European ATM Master Plan. It is an important reference for global interoperability and harmonization, as it has been adapted for Europe from the International Civil Aviation Organisation (ICAO) Global Air Traffic Management Operational Concept,

- The **SESAR reference architecture i.e. European ATM Architecture (EATMA)** and the associated **Architecture Description Document (ADD)** delivered mid of 2019. The Architecture Description Document (ADD) provides a high-level blueprint of the European ATM System as a system of interoperable systems. It gives a consolidated overview based on evaluation and integration of SESAR solution architectures. It highlights the parts of the overall architecture, which will need to change to achieve the state expected at the end of SESAR2020 Wave 1 solutions deployment. It is also including the Integrated Roadmap/DataSet, the set of the Operational Improvement Steps (OI), the System and Standardisation Enablers (EN). The European ATM Master Plan uses this information to produce the Level 1 and Level 2 views, and for the Level 3 update,

- The performance consolidation and aggregation of the SESAR 2020 Wave 1 Solutions i.e. **Consolidated Performance Assessment And Gap Analysis Report (PAGAR)** delivered end of 2019. It provides an overview of the consolidation of the performance assessment from the SESAR Solutions. It covers the Safety, Environment, Predictability, Punctuality, Capacity, Civil-Military Cooperation and Coordination, Human Performance and ATM Security, and Cost Efficiency Key Performance Areas (KPAs). It also contains important information related to the relationship between the SESAR Solution used for the construction and refinement of the deployment scenarios of the 2019 edition of the European ATM Master Plan,

- Various updates to the **Architecture and Performance Frameworks and Guidance documents** used to design and validate the SESAR solutions. Architecture and Performance framework and supporting guidance and methodologies are now part of the SESAR 2020 programme library, meaning they are to be considered by all the SESAR Solutions when defining and validating SESAR concept and technology.

PJ.20 AMPLE 'Master Plan Maintenance': the overall objective of the project PJ.20 is to support the SESAR JU in its Master Planning activities. Essentially, it consists in maintaining, updating and publishing as and when necessary the ATM Master Plan, for its three levels (Executive, Planning and Implementation views). In 2019, a key task was also to support the SESAR JU in the Master Plan update campaign through a transparent and collaborative process involving all stakeholder categories and the key institutions of European ATM (European Commission, Eurocontrol, the European Aviation Safety Agency - EASA, the Network Manager - NM, the SESAR Deployment Manager - SDM, the European Defence Agency - EDA, and EUROCAE).

PJ.20 was composed of a consortium of 21 active partners, thus ensuring a wide and genuine collaborative process. It was split in three Work Packages: WP1 dealing with the overall management of the project; WP3 dealing with the Ethics requirements; WP2, the Master Plan maintenance package, constituting the core part of PJ.20 work which, in 2019, was split into eight Sub-Work Packages.

In 2019, work of PJ.20 was ongoing, mainly supporting the Master Plan update campaign started in December 2017 and continuing over 2019, first for supporting the SESAR JU in securing convergence with the Airspace Architecture Study and second for supporting the SESAR JU during the formal consultation process. Work can be summarised as follows:

- WP2.1: Built the MP Level 2 data in the form of Data Sets in close cooperation with SESAR projects (specifically PJ.19), connecting to, synchronising with, and supporting the Master Plan update campaign. Maintained the public Master Plan Portal, providing a drill-down from electronic Level 1 contents to Level 2 and Level 3 data/information.

- WP2.2: Ensured inclusion of performance ambitions and future Operational Environments' (OEs) capability requirements definition in SESAR2020 Performance Framework (developed by PJ.19). Supported the definition of the performance ambitions in the Master Plan update campaign. Defined Operational Environments capability requirements at ATM MP Level 2 to support PJ.19 Performance Assessment assumptions and guided WP2.4 on Deployment Scenarios development for the Master Plan update.

- WP2.3: Identified from the SESAR projects the standardisation and regulatory needs and, on this basis and in collaboration with EUROCAE and EASA, developed the standardisation and regulatory needs for the Master Plan update. WP2.3 also ensured consistency and connection with EASA's EPAS (European Plan for Aviation Safety).

- WP2.4: As part of the Master Plan update campaign, provided Deployment Scenarios for SESAR (SESAR 1) Solutions expected to reach V3 maturity one year after Wave 1 closure, including Business Case (BC) and Impact Assessment (IA).

- WP2.5: Delivered as planned by end June 2019 the draft Master Plan Level 3 Implementation Plan 2019 and the Level 3 Report 2019 (covering the period from January to December 2018). Updated in Q4 2019 the 2019 Master Plan Level 3 Implementation Plan, in accordance with the content of the Airspace Architecture Study's transition plan. In addition, contributed (in coordination with the SESAR Deployment Manager) to the drafting of the "State of SESAR implementation" section of the Master Plan Level 1, as part of the Master Plan update campaign.

- WP2.6: Within the overall Master Plan update campaign, delivered the business cases for the Essential Operational Changes and the holistic Business View. Delivered the Master Plan's "companion document" containing the detailed assumptions and methodologies underpinning the Master Plan's performance and business views. For Level 3 "implementation plan" of the

Master Plan, delivered the business cases for the "candidates" for new Implementation Objectives.

- WP2.7: This sub-work package aimed at operating the campaign processes and ensuring the delivery to the SESAR JU of a draft Master Plan Executive View (Level 1), having ensured stakeholders' and key ATM players' involvement and buy-in. In 2019, this was materialised mainly by the support brought to the SESAR JU to compile in a systematic way all the comments collected from the consultation phase, address them and, when accepted, update the Master Plan document as required.

- WP2.8: This sub-work package, dedicated to the preparation of common projects, was not active in 2019.

PJ.22 SEabird 'Validation, Verification and Demonstration infrastructure': the project PJ.22 aimed to address validation and demonstration engineering aspects related to the solutions under development within SESAR 2020 programme. The project developed, maintained and provided a system engineering data management framework (SE-DMF) to support the coherent development and delivery of SESAR Solutions. This framework allowed implementing, at Programme level, an efficient requirement management approach based on a data-centric, data-driven rather than document-based paradigm. The project was also in charge of the maintenance and evolution of the V&VP, V&VI and Demonstration Platform Development Methodology and the identification of potential strategic validation tools and interoperability solutions to improve the SESAR 2020 validation process.

In 2019, the project PJ.22 activities can be summarised, per work-package, as follows:

- The maintenance of processes, methods and tools for system engineering data management and the V&VI and demonstrations Platforms Catalogue in the SESAR programme. The activities included the maintenance of the overall SE-DMF service, support to SESAR solutions and support to the SESAR JU during the SESAR maturity gates e.g. provision of traceability matrix. The project has also worked on the integration with MEGA (PJ.19) to ensure alignment between the requirements and the architectural elements.

- Delivery of the final version of the V&V and Demonstration platform development methodology, training sessions to solution projects and report on the results of the training activities.

- Definition of the final list of candidate interoperability solutions required and the development of specifications. In particular:

  o Specification of a light and cheap interoperability validation infrastructure implementing ED-147;

  o Specification proposal to WG81 for the revision of the Flight Object specified in ED-147 and a new AFTN message in ED-147 for the Flight Plan feeding of industrial prototype systems;

  o Participation and coordination with EUROCAE WG 81.

The activities conducted by PJ.22 supported the execution of the Release process with a focus on maintaining the traceability of the operational and technical requirements (and validation objectives and results). In particular, PJ.22 produced traceability matrices and coverage analysis as an input to the 71 maturity gates. Through these reports, the maturity review could address the coverage of the technical versus operational requirements and the validation objectives and results against requirements. The aim was to confirm that the candidate SESAR Solutions correctly addressed the requirements.

The project was successfully completed and closed in September 2019.

2.1.4 Outcomes from the governance bodies

The governance of the SESAR 2020 programme can be depicted as follows:
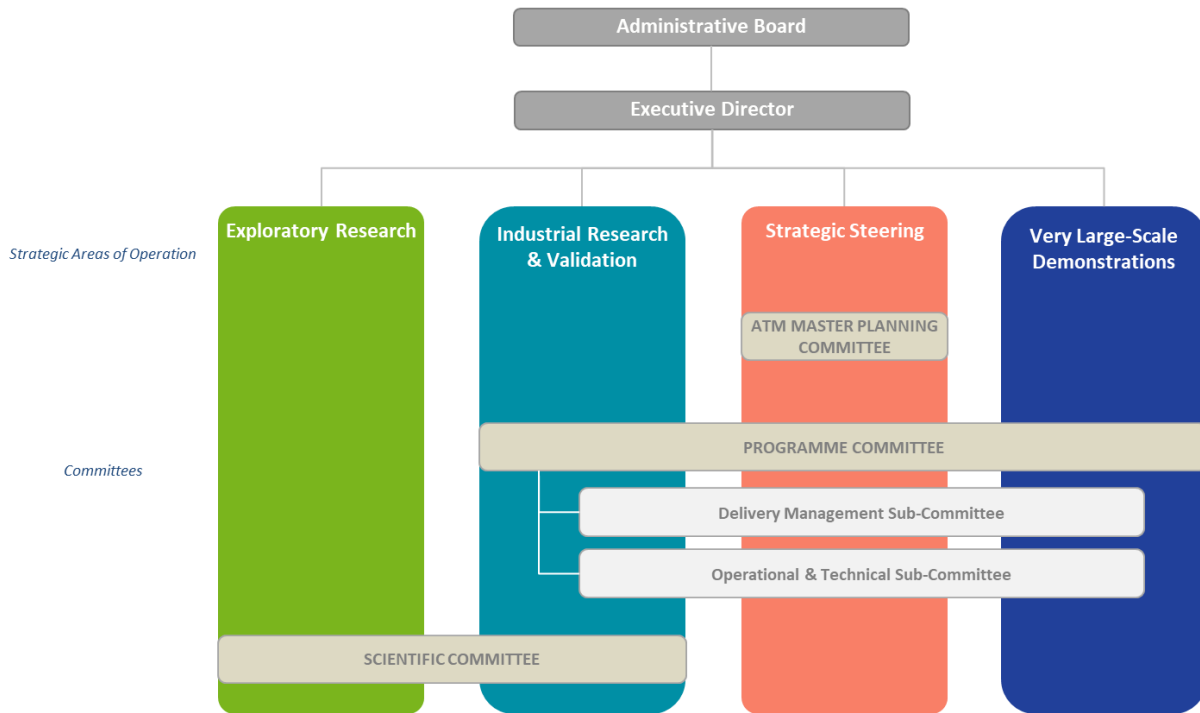
Figure 11: Governance of the SESAR 2020 programme

The following paragraphs summarise the contribution of the Administrative Board (SESAR JU governance) and of the advisory bodies (Scientific Committee, Programme Committee, ATM Master Planning Committee) to the SESAR JU activities in 2019.

2.1.4.1 Activities of the Administrative Board in 2019

Activities of the Administrative Board in 2019 are addressed in Part IIa. Section 3.1.

2.1.4.2 Contributions from the Scientific Committee in 2019

Overall, during the third year of its mandate, the SESAR 2020 Scientific Committee has built on the experience achieved and the activities carried out during the previous two years, according to the work breakdown and tasks performed by the different Task Forces.

It has also to be noted that, on top of the work performed by the several Task Forces, a number of transversal activities have been carried out. In fact, also in 2019, as in the previous years, the Committee supported activities related to the SESAR Programme, such as the evaluation of the applications for the Young Scientist Award, the evaluation of the papers for the annual SESAR Innovation Days event that took place in Athens, Greece in December, and the review of some key SESAR documents like the Master Plan, the Automation Model and the Performance Framework.

The constant engagement with the SESAR JU communication media (e-news, LinkedIn, Twitter) and the attendance to the Committee meetings of external observers have contributed to boost the

visibility of the Committee to all levels inside and outside the organisation and created a higher awareness of its scope and ongoing work.

Since the Scientific Committee is a working group established in accordance with Article 11 of the SESAR JU Statutes and is mandated by the SESAR JU Administrative Board as an integral part of the JU Governance (and this role is applicable for the full duration of the Programme), at the end of 2018 all the Members confirmed their commitment to continue supporting the work of the Committee. Consequently, in early 2019 their contracts have been extended to cover the period from March 2019 to February 2021.

The outcome of the work of the five active Task Forces during 2019 is summarised hereafter.

The *Scientific Research Agenda Task Force* further assessed the situation on the activity stream "supporting the identification of research needs", clarifying the importance of a differentiation between the Task Force and ER Project Engage in terms of roles and mission while recognizing the importance of alignment with the mission of the Scientific Committee and its available resources.

Therefore it had been decided to suspend own activities on that pillar and to observe the evolution in the mentioned external and internal projects and potentially contribute to those external activities.

On the work stream related to the "SESAR Digital Academy" (see below in 2.2.4.3), the support to the academy initiative was continued. This included the provision of advice on identifying relevant stakeholder groups, the analysis of potential benefits per stakeholder group as well as for the SESAR JU as well as the definition of appropriate boundaries of activities. In addition, means and criteria for evaluating, continuously developing and monitoring the academy were discussed.

Along these lines, the Task Force continued to support the SESAR JU in refining, reviewing and consolidating the academy proposal. However, due to internal reasons the academy initiative was put on hold by the JU until the end of the year. Having re-started these activities in autumn ramping up towards the 2019 SIDs and collecting initial expressions of interest, the Scientific Research Agenda Task Force prepared to transition towards a potential new Task Force supporting a full launch in 2020.

The *Innovation Pipeline Task Force* continued to review the analysis of the "Innovation Pipeline in the ATM". During 2019, it focused on supply to the pipeline, which is to say on the identification of promising Fundamental and Applied Research projects. Several projects presented results of higher quality and at higher maturity levels than expected. A bigger challenge was identified in supporting the transition from ER to IR/VLD, indicating that existing mechanisms under H2020 do not encourage a timely and efficient transition; they contribute to a leaky pipeline.

The Task Force delivered a guidance paper to the SESAR JU making recommendations on how to ensure appropriate knowledge transfer (both subject matter and quality of research) from ER projects into the subsequent development phases.

The Task Force was formally closed by the SESAR JU at the end of 2019, since it achieved its main objective.

The *Performance Measurement Task Force* continues to identify ways to improve performance measurement in ATM. The focus in 2019, through an intensive series of activities, was on collaboration with PJ19.04 and ATM MP experts regarding development of the SESAR Performance Framework update and the Performance View chapter of the 2019 Master Plan. The former will continue into IR Wave 2, regarding performance assessment of SESAR Solutions through the SPF. Wider work on missing indicator development for the future system, and coordination with performance-related ER4 projects is also expected, including further outputs such as detailed recommendation papers on targeted aspects of performance assessment.

The work of the *Automation Task Force* focused on the projection of current trends into the long term (2035+), and on the development of a long-term vision on automation and of an associated research roadmap. Three alternative long-term automation targets/scenarios were analysed, following a community-based process for the incorporation of different stakeholders' views, implemented through an ATM Automation workshop. These efforts are summarized in an Automation discussion paper, which concludes that for the mid to long-term future (2035/2050+) the most appropriate way to progress is to follow an evolutionary approach where a "Holistic Cognitive Support to ATM" vision is finally implemented. This vision remains resolutely human-centric, where human operators remain in control, being assisted by automated processes. But it also advocated for the continuation of research in higher levels of automation, specifically in the area of U-space. Finally, the TF aided the SESAR JU to define the ATM Automation Levels in the 2020 edition of the ATM Master Plan.

Finally, the *Complex System Task Force* assessed that the current SESAR validation process has shortcomings regarding the identification of emergent behaviour already during the early phases of future ATM design. Within six ER and two IR projects, ABMS methods have been identified that are capable of bridging this gap. Because none of the developed ABMS approaches addresses all challenges in identifying emergent behaviour in (early) ATM design, there is need for the development of an integrated ABMS approach.

2.1.4.3   Contributions from the Programme Committee in 2019

Since its establishment in November 2016, the renewed Programme Committee has assisted the Executive Director in defining and putting in execution an effective programme management through strategic guidance and tactical steering of the SESAR JU's work programme, but with its remit limited to the higher maturity industrial research, validation and large-scale demonstration activities.

Four meetings were held in 2019 with the aim of addressing the following key topics:

- As specified in the Multi Annual Work Programme (MAWP), the end of the Wave 1 projects is scheduled by the end of 2019 while the Wave 2 projects will close by the end of 2022. In order to address the Airspace Architecture Study elements not already fully covered in Wave 2 and further address the ATM Master Plan the SESAR JU did plan to launch early 2020 a Wave 3 call restricted to the SESAR JU Members and covering industrial research activities and very large-scale demonstrations. In compliance with the process defined in the SPD 2018-2020 (Section III, paragraph 2.1.2), the consultation of the Programme Committee was held leading to the identification of a short list of Wave 3 SESAR Solutions. This list was baselined at the Programme Committee session 12 held on 2 October. As defined in the consultation process, that date was identified as the cut-off date meaning the close out of the consultation phase. Subsequently, the SESAR JU started the "SESAR JU Finalisation of call material" phase that was conducted in total isolation with the aim to consolidate the technical specifications into the call material for further publication. The final Wave 3 call conditions were documented in the Single Programming Document 2020-2022 and served for the financing decision authorising the launch of the call for proposals and the use of the dedicated budget. The Wave 3 call is planned to be published in the H2020 Funding and Tenders Portal in March 2020.

- The SESAR 2020 programme delivery approach is based on the Release process that identifies on a yearly basis the Solutions that will be delivered at a specific maturity level together with the planned demonstration activities from the VLDs. The Programme Committee supported the SESAR JU in the context of two Releases. The Release 8 (in execution in 2018 until April 2019) delivered its outcomes that were shared with the Programme Committee through the Release 8 Report (more information on the Release 8 outcomes can be found below in paragraph 2.3.1.2.1). The Release 9 Plan defined according to the validation activities information extracted

from the projects schedules was approved by Programme Committee approved in December 2018, launching it into execution until April 2020. Regular reports about the progress of the Release 9 solutions validations were presented to the Members to ensure keeping its execution in line with the plan. The Programme Committee in Q1 2020 will address the definition and approval of Release 10 subject to the launch into execution of the Wave 2 projects.

- Considering that, the IOP solution (Interoperability between ATM Ground Systems) is critical to enable the European aviation infrastructure to evolve towards higher level of interoperability and automation, the Programme Committee closely monitored the progress made in its development. As part of the mitigation action for monitoring the IOP development agreed with DG MOVE, a Go/No-go meeting was held on 6 June with PC Members contributing to the IOP development (IOP Decision Team). In the light of the results of the first IOP validation exercise, meeting the imposed quality and technical criteria, the IOP Decision Team recommended to continue the IOP development. As a follow up, The SESAR JU ED gave his approval to continue developing the IOP solution based on the agreed roadmap with the aim of delivering it by Q3 2020.

- Considering the need for further defining the future R&D activities required to complete the Airspace Architecture Study and address the essential operational changes described in the ATM Master Plan 2020, the PC members were invited to attend a digital Sky Workshop hosted by AT-One in Amsterdam on 6-7 November.

2.1.4.4 Contributions from the ATM Master Planning Committee in 2019

Since its establishment in January 2017, the Master Planning Committee (MPC) has assisted the Executive Director with strategic advice on the maintenance, execution and update of the European ATM Master Plan (the Master Plan), also contributing to maintaining a strong connection between the SESAR development and deployment activities. Consequently, the MPC provided ongoing support during the Master Plan update campaign started in November 2017 through both face-to-face meetings and web conferences, and delivered strategic and expert advice on all the other strategic tasks deriving from Master Planning activities, such as the drones roadmap, the proposal on a second common project, the airspace architecture study and its transition plan.

The Master Planning Committee held two meetings in 2019 (20 March and 8 July).

The meeting of 20 March 2019 was mainly dedicated to:

- The review of the Master Plan draft: The MPC expressed support in principle on the structure, messages and contents of the document. It also encouraged the SESAR JU to carry out its remaining effort to make the appropriate links between the Master Plan and the newly delivered Airspace Architecture Study, in order to show explicitly the convergence and coordination between both documents, the Master Plan being an enabler of the AAS recommendations. It finally focused on the Business view, for which uncertainties remained on the assumptions and scenarios to present, and therefore on the messages to provide. It arbitrated the discussion and therefore gave guidance to the SESAR JU on how to proceed and complete work on this issue.

- The Airspace Architecture Study (AAS): The MPC expressed unanimous support in principle on the AAS as delivered by the SESAR JU to the Commission and congratulated the SESAR JU and the Network Manager for the quality of their cooperation. It also noted the Commission's intention to ask for a transition plan and expressed its willingness to support the SESAR JU in this task as necessary.

The meeting of 8 July 2019 was fully dedicated to the AAS transition plan. The MPC was informed on the planned contents and state of progress of the AAS transition plan preparation, and then provided feedback and guidance on the main issues that required coordination and consensus. The MPC Members also committed to fit within the general consultation process to provide individually more detailed comments and suggestions.

Founding Members

2.2 Strategic Area of Operation 2: Deliver exploratory research (ER)

The SESAR JU met all its objectives related to exploratory research in 2019. This includes the following achievements and results:

- *Call reference H2020-SESAR-2016-1 (ER2 – RPAS call for proposals) projects execution – delivery of results: nine projects delivered their final results; five (56%) were formally closed in 2019, the closure process was in progress for three projects (33%) and one project (11%) will continue in 2020 and deliver its final results (see Subsection 2.2.1)*

- *Call reference H2020-SESAR-2016-2 (ER 3 call for proposals) projects execution – delivery of results: seven projects delivered their final results and were closed; of these seven projects, six (86%) were formally closed in 2019 and the closure process was in progress for two projects (14%); one project will continue until 2021 (see Subsection 2.2.2)*

- *Call with reference H2020-SESAR-2019-2 (ER4 call for proposal) – launch of the call and evaluation of proposals: the call for proposals was launched in April 2019, 128 proposals were received and evaluated. The final evaluation report, ready for submission to the Executive Director at the end of 2019, proposed to award 29 proposals and to move them in the grant agreement preparation phase (see Subsection 2.2.3)*

- *Ensure commitment of the scientific community around the SESAR topics: amongst other events relating to the scientific excellence of the SESAR programme, the SESAR Innovation Days took place in December 2019, during which the Young Scientist Awards and the Digital Sky Challenge took place (see Subsection 2.2.4.2)*

- *Establish the SESAR Digital Academy into operation: the SESAR Digital Academy was kicked off during the SESAR Innovation Days in December 2019 (see Subsection 2.2.4.3)*

In 2019, with the delivery and launch of new ER projects, the SESAR 2020 programme continued to deliver high-value outputs and innovative ideas in fields related to RPAS and U-space (including a U-space concept of operations), fundamental research on ATM system evolution modelling, application-oriented research on airports, trajectory management, and use of GNSS in ATM operations etc.

The SESAR JU also continued to federate the research community on ATM through the SIDs and through the development of the new SESAR Digital Academy, a new initiative that brings together under one umbrella access to SESAR exploratory research activities and outreach relating to education and training.

The SESAR JU delivers exploratory research results (both fundamental research and ATM Application-oriented research) through 45 projects in execution or already closed resulting from the following calls for proposals under the H2020 framework:

- the first exploratory research call, ER1 with call reference H2020-SESAR-2015-1 (28 projects, all closed in 2018),
- the second exploratory research call, ER2 focusing on RPAS, with call reference H2020-SESAR-2016-1 (9 projects),

- the third exploratory research call, coupled with the first Open VLD call, with reference H2020-SESAR-2016-2 (8 projects).

The following paragraphs outline the status and delivery of the 17 ER projects in execution in 2019 – the delivery of the 28 ER1 projects, all closed by the end of 2018, is reported upon in previous SESAR JU Consolidated Annual Activity Reports.

In addition, the fourth exploratory research call was launched in 2019 and has received 128 proposals. The evaluation took place end of 2019 and resulted in the proposal for award of 29 grants. Grant agreements are foreseen to be signed in Q2 of 2020.

Moreover, exploratory research encompasses other activities: the SESAR innovation Days, the participation to relevant research events or fora and mechanisms set up by the Knowledge Transfer Network (e.g. PhDs), on top of workshops and open days from the individual ER projects.

2.2.1 Status of Exploratory Research 2 call on RPAS (H2020-SESAR-2016-1)

The second exploratory research open call for proposals, H2020-SESAR-2016-1[33], was open on 14 July 2016 and closed on 15 November 2016 and aimed to address the domain of Remotely Piloted Aircraft Systems (RPAS) and unmanned vehicles (UAS).

- The **UAS/RPAS integration operational issues** project will deliver the U-space Concept Definition addressing the operational concept to enable the operation of drones of all capabilities in the very low-level (VLL) environment, including urban drone operations, the role of autonomy and operational mitigations to command and control failure/corruptions. The required interface with air traffic control (ATC) and the role of incursion protection against protected areas will be addressed. The U-space concept definition will address operational needs and provide a functional breakdown of the U-space;

- The **RPAS integration technical issues** projects will deliver emerging technology options to support drone operations and integration in the VLL and VFR domains. Emerging technologies and applications for U-space from advanced fields such as IT, telecoms, intelligent systems or robotics will be fast-tracked into providing solutions to specific problems that are core to the near-term development of the EU drone industry. It should also help bridge SESAR U-space research with the wider scientific community and will provide the science necessary to support the safe integration of VLL drones, considering higher levels of automation, security and cyber-resilience.

The evaluation of the proposals received in response to the call for proposals was completed in January 2017 with the award of nine projects with a total value of EUR 8.3 million, followed by the grant agreement preparation phase completed in 2017. The projects have started to deliver their results in 2018. In 2018, 51 deliverables were received from these nine ER projects and 43 were assessed and approved, eight deliverables being still under review at the end of 2018. The table below provides an overview of the projects currently in execution phase, and further detail on the initial activities of each in 2018 can be found in the following paragraphs.

Within the **CORUS** (**Concept of Operation for EuRopean UTM Systems**) project, the Edition 3 of the CONOPS has been released to the community for review in September 2019. This work lays the

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[33] Call conditions were set in SESAR JU Annual Work Programme 2016. Call documentation is available on the [Funding and Tenders Portal](#)

Founding Members

foundations for the description of U-space services and capabilities, includes descriptions of new airspace classification of three different types of airspace volume, named X, Y and Z.

The number and nature of the U-space services differ in the three volumes and as a result, the density and complexity of the operations that can occur differs in each. The intention is that the airspace will be divided into X, Y and Z in function of the air risk, ground risk, the traffic demand and other factors, and thus the cost and complexity of providing and using U-space services will be proportionate to the need that they be used. The CONOPS elaborates the U-space services and proposes how they be used in combination to achieve safety, public acceptance and efficient operation.

The U-space CONOPS (https://www.sesarju.eu/node/3411) contains:

- definition of U-space airspace rules and procedures
    - volumes
    - Operational Practice including Rules of the Air and Flight Rules
    - Spacing & Conflict Resolution
- definition of U-space services and High Level Architecture
- an examination of non-aviation aspects, identifying key issues for society
- Safety Assessment methodology within U-space

The CORUS project review meeting took place on 7 November 2019.

The **AIRPASS (Advanced Integrated RPAS Avionics Safety Suite)** project reviewed existing CNS infrastructures and technologies as well as existing on-board technologies for unmanned aircraft that could support very low-level flights, dense airspace and possible U-space integration. From this, the project has matched every U-space services to the main avionics components of a drone (communication, navigation, automated flight control, and database). The project has then compiled 68 basic requirements for an on-board system concept for drones in a U-space environment.

In 2019, the project has been working on:

- identifying gaps between available and required on-board technologies.
- proposing systems that are able to close these gaps, performing an iterative feasibility evaluation of each proposal.
- defining a functional on-board system concept for use of and interaction with U-space on which future drone regulations can be based

The project is finalizing the general on-board functional architecture together with a holistic concept that includes different instantiations could be possible for specific missions and have no implications to hardware.

The **CLASS** (Ground based technologies for a real-time unmanned aerial system traffic management system (UTMS)) project has developed a set of scenarios and KPIs to cover different situations where cooperative, non-cooperative surveillance and identification can provide useful services for drone operations. CLASS then defined a surveillance system comprising of the Drone-IT (Drone Identifier and Tracker) on-board cooperative sensor system, UAS variant of Aveillant's Holographic Radar called Gamekeeper, integrated with data fusion (with support from NTNU) into a the real time situation

display provided by Unifly. Using the defined system KPIs and scenarios, CLASS performed a series of live trials in October 2018 that shown the feasibility of the technologies providing an integrated surveillance and tracking system. In 2019, the project has

- developed functional & technical requirements for U-space Tracking, Monitoring, Tactical Deconfliction services & capabilities,

- included these services in the frame of the U-space CONOPS,

- concluded that sensitive airspaces require safety oriented tracker:

  o drones have to be equipped with a dedicated tracker (lightweight, affordable) whose performances are close to aeronautical standards,

  o high-performance radars are required to detect any intruder, including non-equipped drone.

The CLASS project review meeting took place on 24 May 2019.

The **TERRA** (Technological European Research for RPAS in ATM) project has identified functional service requirements for U-space Ground Systems based on the collection of operational needs and analysis of CONOPS. Specific targets have been set for the performance of communications, navigation and surveillance services. Non-functional requirements have been defined for the Drone traffic management system (design, security, monitoring and interfaces). The project has analysed new candidate technologies that could be applied to U-space and particularly, machine learning for trajectories prediction and conflict detection. The project has performed a gap analysis of the existing vs proposed technologies for U-space, in order to assess their capability to meet the functional requirements; this includes tests on applicability of ADS-B and GPS in urban canyons to drones. This allows the project to define a basic systems architecture to deploy U-space services.

The main project outcomes are:
- Current CNS technologies allow the deployment of U2 services in simple environments.

- However, the existing technologies present some drawbacks, which limit their application for complex scenarios (Urban environment and high drone densities).

- To allow full U-space deployment, improved technologies are required like 5G, Galileo, EGNOS v3.

- Simulations have shown that artificial neural networks for use in predicting and classifying drone trajectories in the urban delivery and could be a promising solution for conflict detection.

The **DREAMS** (Drone European AIM Study) project has performed an analysis of current data and services employed by traditional aviation users and existing information services used by drone operators/users that are of interest to U-space services. This was done with operator/user input as extensive survey. In 2019 the project finalised the U-space AIM concept and performed validation activities that led to the following main recommendations:

- Identification of new aeronautical feature (e.g. Geofencing) and extension of existing features, in order to include the additional needs coming from U-space.

- The aeronautical data service has to provide the same content with different format and be able to interact with consumers by several protocols (e.g. WMS, WFS, REST) to allow the data exchange considering different clients capability.

- The aeronautical data exchange service has to provide data querying capability in terms of feature type, attribute, temporal, etc.

- The change management for U-space features should be compliant with the specification provided by AIXM exchange model due to the same characteristics.

- Adoption of an approach based on micro-service paradigm (fully compliant with CORUS CONOPS architecture principles).

- The source of the data is critical for safety and security, as in Aeronautical Data Quality concept in traditional AIM.

- The extension of U-space to higher levels of automation and higher traffic densities will introduce the new requirements on information exchange.

The DREAMS project review meeting took place on 20 September 2019.

The **IMPETUS** (Information Management Portal to Enable the integration of Unmanned Systems) project will research on the application of the 'micro-services' paradigm as a flexible and cost efficient solution for lifecycle support of the expected high variety of drones and missions. IMPETUS identified the information needs of drone users by reviewing the entire drone operational lifecycle. A key takeaway of this review was that many of the 'apparently' big differences between ATM and U-space have to do mainly with scale aspects. Drone information services will be significantly more detailed, diverse and dynamic. Safety critical information, for instance, will be needed at a much higher fidelity than in today's solutions, such as geospatial information services to ensure surface clearance, local weather information to calculate drone trajectory uncertainties and non-conventional navigation sources (such as signals of opportunity and vision-based navigation) to allow for more precise navigation on a local scale.

Based on these needs, IMPETUS has elucidated the requirements of an architecture based on the micro-services paradigm. This architecture provides key benefits such as flexible and rapid updates, making continuous deployment of the service possible; agile exchanges between functions, thanks to the use of efficient APIs exchanging data using simple message formats; availability of data for each micro-service due to de-centralized data management.

In 2019 IMPETUS replicates several aspects of this architecture to evaluate whether it can meet some of the challenges that the team has identified for the U-space system. For instance, one experiment explores how a drone deconfliction service can interact with other services in the system to maximize the airspace capacity for drones based on dynamic volumes. Such dynamicity would greatly improve airspace utilization, however at the price of higher complexity in air traffic management solutions and capabilities of UAS operating in such airspace.

The **Droc2Om** (Drone Critical Communications) project has performed a first real-life measurement campaign in the city of Aalborg Denmark. Key capabilities such as the Command & Control (C2) link are explored and validated in this project. As an example, the project has developed validation scenario designed from the U-space blueprint to develop functional and technical requirements on the communication infrastructure and the drones. Two real-life measurement campaigns have been performed in Denmark (urban area) to determine if we can use the existing commercial cellular system (4G) instead of a specific communication infrastructure for U-space.

The project main conclusions are:

- The existing cellular systems can support C2 data link communication. It may require enhancements under higher cellular load scenarios – with enhancements implemented on the drone side, and at moderate complexity.

- Hybrid architecture combines low latency and coverage of cellular with reliability and scalability of satellite communications for overall robust C2 performance.

The main project outcomes are:

- specification of an integrated cellular-satellite inter-system design,

- development of an Interactive simulation environment for scenario-based evaluation of C2 performance over Hybrid Cellular-Satellite DataLink,

- assessment of the impact on EUROCAE standardization and 3GPP specifications related to LTE support for aerial vehicles.

The DROC2OM project review meeting took place on 22 August 2019.

The **PercEvite** (Sense and avoid technology for small drones) project has developed a multi-communication package with Wi-Fi, LTE, and ADSB-in. This package allows drones to communicate information on their own position to other air users, communicate with other drones, and receive messages from manned aircraft (ADSB-in). Communication will be an important way to ensure sufficient clearance between different air users. The project has implemented a solution for obstacle detection and avoidance, which uses the two cameras and processing of the Parrot SLAM dunk. In particular, the method uses both stereo vision (to see distances) and optical flow (to estimate the velocity of the drone). This allows the drone to fly both indoors, where the GPS signal is bad or absent, and outdoors. The drone can fly autonomously and stop if it detects obstacles. The project has developed software to see distances in a single image. This way of seeing distances is complementary to using stereo vision (triangulation with two cameras), and has the potential to improve distance estimation. Finally, an audio dataset has been collected with helicopter sounds for non-collaborative, audio –based detection of manned aircraft.

So far in 2019 the project has:

- finished the communication package,
- made an audio dataset that will be made publicly available so that the machine learning community can contribute to audio-based aircraft detection.

The **SECOPS** (An Integrated Security Concept for Drone Operations). Given the highly automated nature of U-space, cyber security is particularly important. A preliminary cyber security risk assessment was performed by SECOPS to determine the risks concerning confidentiality, integrity and availability (CIA) of the U-space information flows.

The task of security is to assure that these risks are on an acceptable level by means of mitigating actions where needed. By assessing and prioritizing potential security risks, the SECOPS Integrated Security Concept defines requirements and proposes potential security controls.

The most critical security issues identified by the project are:

- the trustworthiness of drone functionality,

- the availability/Trustworthiness of drone track information / drone position,

- the validity of geofence information,
- the validity of registered information,
- the timeliness to react upon events.

An experimental proof of concept integrating COTS technologies was executed in order to proof feasibility of parts of the integrated security concept and co-operability of the more mature technical solutions.

2.2.2 Status of Exploratory Research 3 call (within the call with reference H2020-SESAR-2016-2)

The third open exploratory research call for proposals, within the call with reference H2020-SESAR-2016-2[34] also covering very large-scale demonstrations (VLD Open 1), was open on 15 December 2016 and closed on 11 May 2017. The H2020-SESAR-2016-2 call for proposals consisted of two different Work Areas: 'Exploratory Research' covering six topics and 'Very Large-Scale Demonstrations' covering a further 10 topics. The total budget of the call was EUR 28 000 000, of which EUR 10 000 000 for exploratory research (the EUR 18 000 000 other for VLD, see Section 2.4). The evaluation of the proposals was completed in September 2017 for the 'Exploratory Research' Work Area with the award of eight projects and the subsequent grant signature process, for a total value of EUR 9.9 million (in December 2017). The grants awarded in that context will deliver their results in the period from 2018 through to 2020. In 2018, 37 deliverables were received from these eight ER projects and 25 were assessed and approved, 12 deliverables being still under review at the end of 2018. The following paragraphs outline the outcomes of the projects in 2018.

The project **DOMINO** (Novel tools to evaluate ATM systems coupling under future deployment scenarios) project developed a toolbox with the aim of providing the basis of a future, more exhaustive decision-making tool offering both flight and passenger perspectives. At the end of 2019, the project worked on the delivery of:

- the definition and review of new metrics able to capture these network effects;
- a platform which would serve as a test bed for new mechanisms (procedures, technology or regulatory changes);
- a methodology to study any change of architecture with a better understanding of the effect of changes for flights and passengers.

So overall Domino has delivered end of 2019 a simulator and algorithm at the level of TRL 2 and able to model a single day of operation down to the passenger level. The simulator has been calibrated on real data and validated through stakeholder consultations. The model is able to simulate key stakeholders, such as, passengers, airlines and the network manager, in an integrated simulator and can serve as a test bed for different types of simulations. As a consequence different optimisation processes, levels of congestion, levels of compensation and duty of care for passengers are all examples of modifications which can be tested, relying on a realistic representation for the other components of the model.

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[34] Call conditions were set in SESAR JU Annual Work Programme 2016. Call documentation is available on the Funding and Tenders Portal

The **EvoATM** (Evolutionary ATM) is a project that focused on building a framework to better understand and model how architectural and design choices influence the ATM system and its behaviours, and vice versa how the expected ATM overall performances drive the design choices. The EvoATM project completed and concluded at the end of 2019 and delivered and demonstrated at TRL 2 level a new modelling methodology to support:

- the assessment, in terms of performances, of the impact of new solution on an ATM system, evaluating the human factors,

- the optimal design of the new solution to achieve the fixed performances,

The main project achievements with related benefits and impacts can be summarised:

- a new guided approach to fast-time simulation,

- a usable methodology to link the human factors to the technical factors,

- a usable approach to modelling and simulation at of individuals belonging to the system, the interaction dynamics of these individuals within a selected subset of network partitions (community or core/periphery) of the system, for example a local airspace portion, such as an elementary sector, a sector, a set of adjacent sectors, an Area Control Centre (ACC), etc.,

- a common simulation approach and framework.

The **ENVISION** (Enhanced Situational Awareness through Video Integration with ADS-B Surveillance Infrastructure on Airports) project closed on 31/12/2019. The project aimed at assessing how to make use of technical progress in closed circuit television (CCTV) cameras, light detection and ranging (LIDAR) technology and image processing techniques, and at taking advantage of reduced equipment costs, to provide regional and local airports safe and affordable surface movements surveillance capabilities in support of advanced surface movement guidance and control system (A-SMGCS) and airport collaborative decision making (A-CDM) services. In 2019, the project improved the ENVISION low-cost surveillance prototype, deployed it at Carcassonne airport, France, ran some tests in this environment and analysed the results. This activity supported the refinement of the concept and technical specifications and the assessment of the potential benefits. The main outcomes from the project are:

- It confirmed the need for low-cost surveillance solution alternatives in secondary airports, in particular medium size airports where benefits of A-SMGCS are most obvious.

- Hybrid solutions relying on video detection complemented with other technologies are of great potential.

- Learning applied in video analytics proves very interesting for object detection and categorization.

- While LiDAR effectively enhances accuracy of the detection including in moderate rain and night-time conditions, current costs and technical limitations degrade the benefit/cost ratio for this technology.

- Further R&D is recommended to improve the current video-based detection and tracking functions and to evaluate complementary low-cost sensor technologies increasing reporting accuracy and allowing operations in all visibility conditions.

The **ADAPT** project (Advanced prediction models for flexible trajectory-based operations) project focused on proposing strategic models to predict the volume, flexibility and complexity of traffic demand taking into account both individual flights and network infrastructure (i.e. sectors and airports). The aim is to enable early flight information sharing in order to identify potential network bottlenecks and the degree of flexibility of all flights. At the tactical level, the extent to which strategically assessed pre-departure and en-route flight flexibility mitigates actual network congestion, will be evaluated.

The **COTTON** (Capacity Optimisation in TrajecTory-based OperatioNs) project focused on maximising the effectiveness of capacity management processes in trajectory-based operations taking full advantage of available trajectory information. Specifically, the project explores the integration of demand and capacity and flight centric solutions.

The **EMPHASIS** (EMPowering Heterogeneous Aviation through cellular SIgnalS) project focused on increasing safety, reliability and interoperability of general aviation/rotorcraft (GA/R) operations both with commercial aviation and with emerging drones operations. These aspects are foreseen as critical elements to secure and improve airspace access for GA/R users in future airspace environment and improve operational safety of their operations.

In 2019, the project EMPHASIS addressed four main technological elements and for all of them is achieved maturity is at least TRL2. The assessment of individual technologies:

- datalink over LTE/5G for aviation apps:

  o technology concept and constraints in terms of GA formulated based both on literature and on simulations;

  o basic principles of 4G and 5G for GA communication links studied and their parameters for practical applications have been provided.

- network-based navigation using 4G and 5G:

  o RF network-based navigation methods studied and reviewed, new concepts for integration with GNSS and INS navigation developed and implemented (prototype software level);

  o technology concepts tested and validated through simulations in relevant scenarios.

- a low-power ADS-B concept:

  o concept and operational needs documented, system designed and prototyped including experimental hardware;

  o concept validated through simulations and flight testing in real environment.

- affordable obstacle detection:

  o concept and operational needs identified and documented.

  o concept assumption validated using COTS components and real data collected from external sources (maps/databases) or recorded in real environment (mmW radar), results and limitations documented.

The project also investigated an alternative approach on how to certify some of the avionics functions. It aims is to support usage of COTS components and scalability. The possible application of the proposed approach has been demonstrated on the concept of affordable ADS-B.

The **GATEMAN** project (GNSS Navigation Threats Management) project focused on researching multiple measures that could be deployed on most aircraft to manage GNSS threats, either on their own or in a collaborative fashion with other aircraft. Indeed, Global Navigation Satellite System (GNSS), such as the Galileo constellation, will become the primary means of aircraft navigation in the mid and long term. However, GNSS signals are vulnerable to threats, especially to jamming and spoofing, which may cause the total loss of navigation.

In 2019, GATEMAN completed its exploratory research work on a novel concept for integrated GNSS interferences air navigation threats management, aiming at, on the one hand, their detection and localization and, on the other hand, their mitigation, either to keep GNSS navigation operative. If that was not possible, to revert to a cost effective alternative technology (5G) that is able to support GNSS-based approaches. The work can now be considered for industrial research with an initial evaluation of TRL2.

- After the successful verification of the algorithms, a demonstrator (i.e. prototype) was elaborated to complete open-field experiments. After analysing the results, some issues were identified and improvements were suggested to achieve the functionality expected. In addition this concept of interferences threats management defines an operational mode in which a Ground Facility would be involved, aggregating the information received from the aircrafts and providing a better estimation of the localization of the source and the denied GNSS-service volume.

- GATEMAN project has also evaluated mitigation techniques at signal-processing level (spoofing monitoring) to enhance the robustness of GNSS positioning against spoofing attacks. Additionally it has evaluated some alternatives positioning technologies (A-PNT) based on 5G to obtain navigation during GNSS jamming events.

The **Engage** project was launched in January 2018 in the context of the ER3 Call to perform the role of SESAR 2020 Knowledge Transfer Network (KTN) in support to the SESAR JU and is managed by a consortium of Academia and industry. Its focus is two-fold: inspiring new researchers and helping to align SESAR exploratory and industrial research, through a wide range of activities and financial support actions. The Network aims in particular to stimulate the transfer of Fundamental research results towards ATM Application-Oriented research, and from Application Oriented research to industrial research. The successful implementation of the Innovation Pipeline in SESAR 2020 will rely largely on the effectiveness of the knowledge network initiatives organised by Engage.

In 2019, the project organised four Thematic Challenges workshops covering the topics of Vulnerabilities and global security of the CNS/ATM system (Brussels, 17 June), Efficient provision and use of meteorological information in ATM (Brussels, 5 November), Novel and more effective allocation markets in ATM (Madrid, 12 November) and Data-driven trajectory prediction (Athens, 02 December).

Through the first Call for Catalyst Funding launched by Engage and closed in Feb 2019, 21 proposals on the four Thematic Challenges were selected, for a total budget of EUR 1.21 million. Furthermore, in the context a PhD Call launched by Engage and closed in 2018, 10 proposals were funded, for a total budget of EUR 824 000. The selected Catalyst projects have a duration of two years, while the PhDs

have a duration of three years. The selected PhDs and Catalyst Funding projects presented their intermediate results at the Engage workshops held at the end of 2019.

The project also supported the SESAR JU in the organisation of the ninth SESAR Innovation Days in Athens in December 2019, which are further described below in Subsection 2.2.4.1.

Finally, the University of Belgrade hosted in September in Belgrade the first Engage Summer School, providing tutorials on key ATM concepts and challenges as well as on research methodologies, including case studies and presentations of prominent SESAR exploratory research projects.

2.2.3   Status of Exploratory Research 4 call (with reference H2020-SESAR-2019-2)

The fourth open exploratory research call for proposals, within the call with reference H2020-SESAR-2019-2[35], was opened in April 2019 and closed in August 2019. The H2020-SESAR-2019-2 call for proposals consisted of two different Work Areas:

- ATM Excellent Science & Outreach aims at bridging ATM research with the wider research community and will provide the necessary scientific support to ATM change either directly or through connection research areas in other disciplines or sectors. Consequently, the purpose of this research area is to investigate through research and innovation actions which new technologies, methodologies, concepts, or validation methods developed in non-ATM sector could be introduced in the context of ATM and in particular serve the identified SESAR business needs and Flightpath 2050 vision, or identify new ATM business opportunities. The Work Area covers the following scope:

  o   Automation & Autonomy

  o   Complexity, Data Science & Information Management

  o   Environment & Meteorology for ATM

  o   Performance, Economics, Legal & Regulation

  o   ATM role in Intermodal Transport

  o   CNS for ATM

- ATM application-oriented research will help mature new concepts for ATM beyond those identified in the European 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 SESAR JU. The Work Area covers the following scope:

  o   High Performing Airport Operations

  o   Optimised ATM Network Management

  o   Advanced Air Traffic Services

  o   Enabling Aviation Infrastructure

  o   ATM operations, architecture, performance & validation

  o   IFR RPAS

  o   U-space

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[35] Call conditions were set in SESAR JU Annual Work Programme 2019. Call documentation is available on the

The total budget of the call was EUR 38 564 361, of which EUR 15 500 000 for Work Area 1 and EUR 23 064 361 for Work Area 2. The evaluation of the proposals was completed at the end of 2019 and the evaluation report was submitted to the Executive Director of the SESAR JU in January 2020. This step is to be followed by the Grant Preparation Phase for 16 projects for a total value of EUR 15.6 million for the Work Area 1 and for 13 projects for a total value of EUR 22 million for the Work Area 2. The Grant Preparation Phase should be completed by the end of April 2020. The grants awarded in that context will deliver their results in the period from 2020 through to 2022.

2.2.4 Other activities related to exploratory research

2.2.4.1 SESAR Innovation Days (SIDs)

The ninth edition of the SESAR Innovation Days (SIDs) took place between 2 and 6 December 2019 in Athens Demokritos National Centre for Scientific research (NCSR). The event put air traffic management (ATM) exploratory research in the spotlight through a series of workshops, presentations, poster exhibitions and networking events. More than 300 participants, mainly from European research and development centres and universities, but also involving international guests and Programme Committee members, attended the event. Over 300 participants attended the SIDs, which featured technical presentations, plenary talks, panel discussions and numerous networking activities. The SESAR JU organised the event with the support of the SESAR KTN 'Engage' project which took responsibility of the programmatic, i.e. scientific content of the conference. Engage provided a detailed report while the main aspects are summarised in the following paragraphs.

The SIDs are the main vehicle for the SESAR JU to share progress and disseminate results of its exploratory research programme. More specifically, the objectives of the event are to:

- pool together Europe's academic and scientific ATM research community and provide them a platform to show their achievements and disseminate their results,

- in particular, disseminate the research results from SESAR 2020 exploratory research,

- showcase how new thinking and ideas that come out of SESAR's exploratory research projects can feed ATM industrial research,

- provide a backdrop for the SESAR Young Scientist Award.

A call for contributions, soliciting paper and poster submissions, was published in May 2019 via the SIDs website, and announced through emails, SESAR Newsletters and the Engage website. Submissions through SESAR ER and IR projects were encouraged but the call was open to all relevant ATM research. A total of 71 full papers and 23 posters were submitted and reviewed by the Programme Committee, including reviewers from the SESAR Scientific Committee, of which 38 papers and 21 posters were accepted.

All 38 papers were assigned to thematic tracks and integrated as sessions of 2-4 paper presentations into the conference programme. Whilst keynotes, plenary talks and discussion panels took place in plenary sessions, technical sessions were conducted in parallel sessions.

The conference started with the inauguration of the poster exhibition on Monday. Two workshops and a number of additional meetings were organised in association with the SIDs; these were not part of the official programme but co-located seeking synergies with the main conference. The COTTON workshop and the Engage Thematic Challenge workshop 'TC2 - Data-driven trajectory prediction' took place at NCSR on 2 December.

The Digital Sky Challenge took place at Athens airport at the same time and, although not formally part of the SESAR Innovation Days, the SESAR JU decided to tie these two events together.

The closing session on Thursday afternoon included the Young Scientist Award ceremony and the announcement of the SIDs 2020, which will be held in Budapest.

All relevant information including call for papers, submission instructions, logistical information and, at a later stage, programme and conference registration were available via the SIDs website. All posters and papers are available for download from the website together with the presentations. A dedicated smart phone application was also available which included relevant information and allowed users to comment and engage in dialogue.

2.2.4.2 The Young Scientist Awards (YSA)

Along with the publication of the call for contributions for the SIDs, the annual edition of the Young Scientist Award contest (YSA 2019) was publicly launched on 6 May 2019, and the deadline for the submission of the applications was 6 September 2019. The call targeted any young scientist who has contributed to scientific achievements within the area of Air Traffic Management and Aviation within their Bachelor, Master or PhD thesis defended not more than 18 months before the date of publication of the call, or on-going PhD, and being a citizen or a resident in an EU Member State or an Associated Country to the Horizon 2020 Research and Development Framework Programme.

Several applications were received. First, they were checked by the SESAR JU Legal Unit against the eligibility criteria described in the YSA 2019 Contest Rules published together with the call. Successful applications were sent to the Evaluation Panel for the award phase. The Evaluation Panel was composed of three members of the Scientific Committee. At the end of October 2019, the Panel sent the Evaluation Report to the SESAR JU, according to which the following winners were proposed:

- First place: Junzi Sun, Delft University of Technology, for his novel scientific approaches to modelling different aspects of aircraft performance. Rooted in the philosophy of open data and open models, the results of this research provide a framework that enables more transparency and comparability for future ATM research;

- Second place: Javier Alberto Perez Castan, from Universidad Politécnica de Madrid, for his research into continuous climb operations in high-density scenarios to reduce the capacity and safety impact of traffic around airports.

- Third place: Leonid SEDOV, Linköping University, for his research on capacity estimations and route planning for the management of dense drone traffic in very low level (VLL) uncontrolled airspace

The SESAR JU Executive Director endorsed the recommendation from the independent panel.

The three short-listed scientists were awarded during the SESAR Innovation Days (SIDs) 2019.

2.2.4.3 SESAR Digital Academy

The year 2019 saw the launch of the SESAR Digital Academy - a learning initiative supporting Europe's future aviation and ATM workforce. The mission is to nurture Europe's brightest minds and advance learning, scientific excellence and innovation in aviation and ATM. The Academy aims to promote student mobility and a whole spectrum of learning opportunities, from fundamental research to industry-focussed applied research, and to enhance the knowledge, skills and employability of aviation professionals.

The SESAR Digital Academy seeks to bring together under one umbrella access to SESAR exploratory research activities and outreach relating to education and training, as well as professional learning opportunities offered by research centres, universities, industry partners and other entities within the ATM/aviation domain.

The mission and vision of the SESAR Digital Academy are complementary to those of existing aviation/aeronautics interest groups, associations and networks at European level. The Academy will seek to identify synergies and potential for collaboration as part of its plan of activities.

The Academy's mission is guided by the following set of values:

- promoting the sharing of knowledge, ideas skills and expertise on air traffic management and aviation research across academia and industry, both within Europe and beyond;

- nurturing the professional development of the future aviation workforce by creating learning and knowledge exchange opportunities;

- advancing scientific excellence and know-how in ATM and aviation research, encouraging research across disciplines on the most promising ideas and concepts;

- promoting equal opportunities in ATM and aviation research and more broadly the industry, recognising diversity and inclusion as key to the competitiveness of the industry.

The Digital Academy is an open initiative with a wide range of participants and beneficiaries: students and academia, research institutes, industry, standardisation, regulatory and safety authorities.

2.3 Strategic Area of Operation 3: Deliver industrial research & validation (IR)

The SESAR JU met all its objectives related to industrial research and validation in 2019. This includes the following achievements and results:

- *Finalise validation exercises of Release 8 and draft final report: 100% of validation exercises of Release 8 were completed and the Release Report was delivered and approved by the Programme Committee in April 2019 (see Subsection 2.3.1.2.1)*
- *Execute validation exercises of Release 9: the first Release 9 validation exercises were executed according to the plan approved by the Programme Committee in March 2019 (see Subsection 2.3.1.2.2)*
- *Call reference H2020-SESAR-2015-2 (IR-VLD Wave 1 call for proposals) – Wave 1 projects delivery of results: 14 IR Wave 1 projects (82%) were in execution, completed the delivery of their final results and were formally closed in 2019, and three (18%) were still in execution at the end of 2019 (see Subsection 2.3.1.1)*
- *Call with reference H2020-SESAR-2019-1 (IR-VLD Wave 2 call for proposals) – launch, evaluation and award of the IR projects: for the ten IR projects selected as a result of the Wave 2 evaluation process, the grant agreement preparation process concluded successfully and these projects were launched into execution on the 1st December 2019 (see Subsection 2.3.2.1)*
- *Gap analysis for Industrial Research and Validation against the ATM Master Plan: the gap analysis was conducted and the definition of the Wave 3 call for proposals, including IR topics, was completed at the end of 2019 (see Subsection 2.1.4.3)*

The year 2019 was a year of success in delivering 21 Solutions ready for implementation, that contribute to increasing the performance of the European ATM system, especially in the areas of efficiency, capacity and punctuality. The delivery of nine additional Solutions in early 2020 was also secured, and the launch of ten Wave 2 projects in 2019 will increase the performance improvements over the period from 2020 to 2022.

Through Wave 1, and as planned in Wave 2, the SESAR programme accelerated the pace of innovation in ATM by more than 30%.

At the beginning of 2019, the 17 IR projects and three transversal steering activities projects (see above paragraph 2.1.3) resulting from the IR/VLD Wave 1 call for proposal launched in 2015 (call with reference H2020-SESAR-2015-1) were in full execution. This represents a total EU co-financing amount of EUR 202.7 million.

With the aim to assess the maturity of the SESAR Solutions developed in the 17 IR projects, the SESAR JU and its Members finalised the Release 8 and conducted the Release 9 in 2019. Additionally, the SESAR JU started the planning phase of the Release 10, expected to be completed in the beginning of 2020. This chapter presents the status of the projects resulting from the Wave 1 call for proposals and their main achievements in 2019, then the results and achievements of the Release 8 and the execution status of the Release 9.

Furthermore, in 2019 the SESAR JU ran the IR-VLD Wave 2 call process, which led to the signature of 13 grant agreements (12 in IR, one in VLD) and the launch of the corresponding projects into execution

for a total value of EUR 138.5 million (of which EUR 86.9 million of signed grant agreements[36]). Two grants are still in preparation phase with the objective to finalise it by Q1 2020. Subsection 2.3.2 below describes this process and provides further information on the Wave 2 projects.

2.3.1   Completion of SESAR 2020 Wave 1 projects (IR-VLD Wave 1)

2.3.1.1   Project activities and results in 2019

The first call on industrial research and validation, which was restricted to SESAR JU Members other than the Union, within the call with reference H2020-SESAR-2015-2[37] also covering VLD, closed in 2016, followed by the award of 17 projects. The main outcome of these projects is summarised in the paragraphs below.

In 2019, 915 deliverables were received from the 17 IR projects and 859 were assessed and approved, 53 deliverables being still to be delivered in 2020 from the five Wave 1 projects still in execution. Furthermore, IR projects contributed to validation exercises which are presented in the Subsection 2.3.1.2.2 which summarises the Release 9 execution and temporary results (as per the Release Plan, Release 9 will finish in Q1 2020).

<table>
<tr><td>✈ 🛫 High-performing airport operations</td></tr>
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Under the '**High Performing Airport Operations**' Key Feature, IR projects delivered the following:

The project **PJ.02 EARTH** 'Increased Runway and Airport Throughput' focuses on developing, validating and delivering separation and procedures to improve runway and airport throughput considering wake vortex, weather, the environment and noise while taking account of different levels of traffic demand, future aircraft capabilities and airport configurations. The activities in the project scope are:

- PJ.02-01 'Wake turbulence separation optimisation'. Several independent solutions will likely be identified in this area. The targeted V3 maturity level may not be achieved for all these solutions in Wave 1. This will be checked in a maturity gate by the end of Q1 2020;

- PJ.02-02 'Enhanced arrival procedures'. Several independent solutions will likely be identified in this area. The targeted V3 maturity will most probably not be achieved in Wave 1. This will be confirmed in a maturity gate by the end of Q1 2020;

- PJ.02-03 'Minimum-Pair separations based on RSP'. The solution aims to achieve a V3 maturity level by the end of Q1 2020;

- PJ.02-05 'Independent Rotorcraft operations at the Airport'. The solution aims to achieve a V3 maturity level by the end of Q1 2020;

- PJ.02-06 'Improved access into secondary airports in low visibility conditions'. Two independent solutions will likely be identified in this area. The targeted V2 maturity level may not be achieved for all these solutions in Wave 1. This will be checked in a maturity gate by the end of Q1 2020;

- PJ.02-08 'Traffic optimisation on single and multiple runway airports'. This activity was split up into four independent solutions at the end of 2019:

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[36] The rest remaining to be installed in 2020 through the grant budget amendment procedure as defined in the SESAR JU's Annual Work Programme for 2015, adopted by the Administrative Board on 23 October 2015
[37] Call documentation is available on the Funding and Tenders Portal

- o PJ.02-08-01 'trajectory based integrated runway sequence'. This solution achieved a V3 maturity level;
- o PJ.02-08-02 'runway manager'. This solution aims to achieve a V3 maturity level by the end of Q1 2020;
- o PJ.02-08-03 'increased runway throughput based on local ROT characterisation (ROCAT)'. This solution aims to achieve a V3 maturity level by the end of Q1 2020;
- o PJ.02-08-04 'Optimised use of runway capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT)'. This solution did not achieve V3 as expected because of the lack of quantitative benefits, its limited applicability and unsolved technical limitations;
- PJ.02-11 'Enhanced Terminal Area for efficient curved operation'. The solution aims to achieve a V1 maturity level by the end of Q1 2020.

In 2019, the project team performed the last validation activities, consolidating the results in the final documents to be included in each solution data pack, some of which were delivered before the end of the year.

The project **PJ.03a SUMO** 'Integrated Surface Management' closed on 31/12/2019. It aimed at:

- Optimising the allocation of airport resources for smoother and more predictable airport operations in all weather conditions;
- Developing resilient airport systems especially when low visibility procedures are in place;
- Improving accessibility to airports operating in low visibility conditions by:
  - o Providing flight crews with an enhanced vision aid to perform approach, landing and taxi operations with an increased safety level;
  - o Providing accurate and available navigation information with higher integrity provided by aircraft systems;
- Considering the integration of remotely piloted aircraft systems (RPAS) in the surface operations when allocating airport resources.

The activities in the project scope were:

- PJ.03a-01 'Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing'. The maturity gate that took place in November 2019 concluded that PJ.03a-01 as a solution did not achieve the target V2 maturity level, considering the lack of clarity on the scope, the lack of clarity on the difference with the SESAR 1 mature solutions and the lack of quantified performance benefits. A proposal for splitting up the activities into independent solutions was made at the end of Wave 1. It will be considered as an input to the Wave 2 follow-up activities;
- PJ.03a-03 'Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface'. The solution achieved a TRL4 maturity level at the end 2019;
- PJ.03a-04 'Enhanced Visual Operations'. The solution achieved a V3 maturity level at the end of 2019;

- PJ.03a-09 'Surface operations by RPAS'. The solution achieved a V2 maturity level at the end of 2019.

In 2019, the project team performed the last validation activities and consolidated the results in each solution data pack.

The project **PJ.03b SAFE** 'Airport Safety Nets' closed on 31/12/2019. It aimed at defining, consolidating and validating additional safety barriers to mitigate the risks of runway incursion, runway excursion and more generally the risk of incidents and accidents involving aircraft at the airport. The activities in the project scope were:

- PJ.03b-01 'Enhanced Airport Safety Nets for Controllers'. The solution achieved a V2 maturity level at the end of 2019;

- PJ.03b-03 'Conformance monitoring safety net for Pilots'. The solution achieved a V2 maturity level at the end of 2019;

- PJ.03b-05 'Traffic alerts for pilots for airport operations'. The solution achieved a V3 maturity level at the end of 2019;

- PJ.03b-06 'Safety support tools for avoiding runway excursions'. The solution achieved a V2 maturity level at the end of 2019.

In 2019, the project team performed the last validation activities and consolidated the results in each solution data pack

The project **PJ.04 TAM** 'Total Airport Management' closed on 31/12/2019. It took a 'holistic' view of airport operations, including the three key processes (aircraft, passengers, baggage) and more importantly, the interaction between them, as it is the degree of coordination between these different processes which constitutes a significant contributory factor to punctual and predictable operations and ultimately therefore passenger satisfaction. The entire scope of the PJ.04 TAM project was covered by two activities:

- PJ.04-01 'Enhanced Collaborative Airport Performance Planning and Monitoring'. The solution achieved a V2 maturity level in Q1 2019. A V3 validation was planned, executed and reported upon in the remaining of 2019;

- PJ.04-02 'Enhanced Collaborative Airport Performance Management'. The solution achieved a V2 maturity level at the end of 2019.

In 2019, the project team performed the last validation activities and consolidated the results in each solution data pack. The project team, in agreement with the SESAR JU, split up the PJ.04 solutions considering that these were wide in their scope, focused on more than one specific airport type, covering both local and network perspective and encompassing different maturity levels. The solutions on which R&D should continue in Wave 2 are:

- PJ.04-W2-28-1 'Network-connected regional airports', targeting V3 by the end of 2022;

- PJ.04-W2-28.2 'Regional airport(s) collaborative management, targeting V2 by the end of 2022;

- PJ.04-W2-28.3 'Connected large airports', targeting V3 by the end of 2022;

- PJ.04-W2-29.1 'Airside/Landside performance management', targeting V3 by the end of 2022;

- PJ.04-W2-29.2 'MET performance management', targeting V3 by the end of 2022;

- PJ.04-W2-29.3 'ENV performance management', targeting V3 by the end of 2022.

The project **PJ.05 Remote Tower** 'Remote Tower for Multiple Airports' closed on 30/11/2019. It aimed at further developing the multiple remote tower concept compared to SESAR 1 by investigating the feasibility of increasing the traffic volumes, complexity and/or number of aerodromes controlled from one remote tower module and in a remote tower centre. PJ.05 also aimed at developing a technological solution for automated remote weather observations. This work was split up into three solutions:

- PJ.05-02 'Multiple Remote Tower Module'. This solution aims to achieve a V3 maturity level by the end of Q1 2020;

- PJ.05-03 'Remote Tower Centre with Flexible Allocation of Aerodromes to Multiple Remote Tower Modules'. The solution achieved a V2 maturity level at the end of 2019;

- PJ.05-05 'Advanced Automated MET System for Remote Airport'. The solution achieved a TRL4 maturity level at the end of 2019.

In 2019, the project team performed the last validation activities and consolidated the results in each solution data pack.

Advanced air traffic services

Under the '**Advanced Air Traffic Services**' Key Feature, IR projects delivered the following:

The project **PJ.01 EAD** 'Enhanced Arrival and Departure' focuses on operational improvements to the flow of arriving and departing traffic within the E-TMA that aim to increase airspace capacity and cost efficiency, improve safety and predictability and provide greater fuel efficiency and environmental sustainability. It addresses the development of concepts, tools and procedures to increase the capacity of extended TMAs (E-TMAs) to meet forecast traffic growth in a safe, cost-effective and environmentally sustainable manner. This will be achieved by taking advantage of the latest technological developments from both an airborne and a ground-system perspective and through secure sharing of data in seven solutions:

- **PJ.01-01** (Extended Arrival Management with overlapping AMAN operations and interaction with DCB and CTA) Solution investigated the interaction between multiple extended Arrival Management (AMAN) systems, the Network and Airport Demand-Capacity Balancing (DCB) in medium and high density/complexity TMA/E-TMA environments. During 2019, two additional RTS exercises held at NATS and COOPANS were completed and the V2 data pack was delivered. The Solution achieved V2 ongoing at the Maturity gate held in December.

- **PJ.01-02** (Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA) Solution investigated the use of arrival and departure management information to 'identify and resolve complex interactions in the E-TMA'. This Solution covered medium and high density/complexity E-TMA environments, including TMAs with multiple airports. During 2019, NATS conducted an additional RTS exercise and delivered the delivery of the V2 data pack. The Solution partially achieved V2 at the Maturity gate held in November.

- **PJ.01-03a** (Improved Parallel Operations) Solution aimed at addressing today's limitations in many dense TMAs in Europe involving platforms with existing or planned parallel approaches/runways. The Solution provided alternative options for independent parallel operations in medium to high density TMAs, using RNP to replace in particular vectoring to final intercept with closed loop routes and associated operating methods. During 2019, the solution completed its RTS validation exercises and delivered the V2 data pack. The Solution achieved V2 at the Maturity gate held in August.

- **PJ.01-03b** (Dynamic E-TMA for Advanced Continuous Climb and Descent Operations) Solution investigated the facilitation of Continuous Climbs Operations and Continuous Descents Operations through dynamically assigned routes (based on PBN route structures), and/or through use of controller assisted tools and airborne systems support to flight crews, allowing them to enhance flight efficiency along descent. During 2019, a RTS and a FTS validation exercises were conducted and the solution delivered its data pack as an input to the Project Review. The Solution maturity was confirmed V2 on-going.

- **PJ.01-05** (Airborne Spacing Flight Deck Interval Management) investigated the use of techniques that enable pilots to manage their spacing, sequencing and merging with other traffic, including by providing detailed traffic information in the cockpit. During 2019, the solution performed an additional RTS validation exercise and delivered its V2 data pack. The Solution achieved V2 with acceptable Risks at the Maturity Gate held in November.

- **PJ.01-06** (Enhanced Rotorcraft operations in the TMA) validated Rotorcraft Advanced Point-In-Space procedures as an operational enabler for Simultaneous Non-Interfering (SNI) concept of operations to allow Rotorcraft to operate to and from airports without conflicting with fixed-wing traffic or requiring runway slots. During 2019, the Solution 2 performed the additional flight trials in Donauwoerth and finalized its data pack. The solution including the Helmet Mounted Display System (HMD) as an optional technical enabler reached V3 Maturity Level at the Maturity Gate in November.

- **PJ.01-07** (Approach Improvement through Assisted Visual Separation) refers to cockpit display of traffic information (CDTI) assisted visual separation (CAVS) and CDTI assisted pilot procedure (CAPP) applications that enable aircraft to separate each other visually in marginal visual conditions and that facilitate transitions from IFR operations to CAVS. During 2019, the Solution finalized the reporting of the performed validation exercises and delivered the V2 data pack. The Solution achieved V2 with acceptable Risks at the Maturity Gate held in December.

The project **PJ.06 ToBeFREE** 'Trajectory-Based Free Routing' addresses the Free Routing concept, which enables Airspace Users to fly as close as possible to their preferred trajectory, without being constrained by fixed airspace structures or fixed route networks. Free Routing (FR) implementation represents a step towards a less fragmented European airspace foreseen by Single European Sky and provides the AUs with the possibility to fly their user preferred routes in accordance with their business needs or mission requirements. FR will result in a seamless airspace enabling more efficient flight, a reduction in AU costs and will promote cheaper travel, increasing personal mobility and trade.

- PJ.06-01 Solution; Optimized traffic management to enable Free Routing in high complexity environments

- PJ.06-02 Solution: V1 maturity gate was successfully executed and the solution passed to the next stage.

In 2019, PJ06 validated implementation of structurally limited FRA in high and very high complexity en-route airspace. The project PJ06 assessed, and delivered the outcome of the two solutions:

- Solution PJ06-01 "Optimized traffic management to Free Routing in high and very high complexity environments" developed and validated the Free Routing concept in upper en-route airspace within cross-border high & very high-complexity environment. This Solution supports the implementation of European Regulation IR No 716/2014 - PCP AF#3 - Free routing available at and above FL310 in ICAO EUR region. PJ.06-01 started its activities at V2 maturity level and has been brought to V3 maturity level.

  It has been demonstrated that the average fuel consumption per flight is reduced with the implementation of structurally limited Free Route concept. Extrapolated at horizon 2035 and at ECAC level, PJ.06-01 is expected to deliver significant Environment / Fuel Efficiency benefits: a reduction of 26,57kg per flight concerned by the solution has been calculated (which turns into a reduction of 83, 69 kg of CO_2 emission).

  The results of the analysis show that the PJ.06-01 Solution would bring significant benefits to the Airspace Users and great improvement to the network performance. The overall CBA results of the PJ.06-01 show that the NPV is positive with a gain estimated at 797 M€. This result is supported by flight efficiency benefits evidenced in validation exercises and Fast Time Simulations performed by the Network Manager.

- Solution PJ06-02 "Management of Performance Based Free Routing in Lower Airspace", addressed the benefit and impact of expanding the Free Routing concept to the lowest limit possible while accommodating all Airspace Users concerned. PJ.06-02 started its activities at V1 maturity level and has been brought to V2 maturity level.

  This solution is expected to bring benefits from FRA implementation in terms of Fuel Efficiency KPAs. It is expected to bring benefits mostly for AUs, improving Operational Efficiency (fuel efficiency, cost effectiveness), while ANSPs and ATCOs are aiming to maintain Safety and airspace Capacity in FRA of high complexity. It has been demonstrated in the validations that on average planned routings are shorter thus average fuel consumption per flight is reduced within cross-border FRA area. Extrapolated to the horizon of 2035, a reduction of 13,15kg per flight concerned and of 9,98 kg fuel per flight at ECAC level by the solution has been calculated

The project **PJ.10 PROSA** 'Separation Management & en-route & TMA' aims at providing the air traffic controller with more automated tools, thus freeing capacity for situations where human intervention is crucial. This provides even safer service for an increasing amount of traffic and with lower costs, as required by airspace users. The Project concerns the implementation and validation of a series solution:

- Solution PJ.10-01a: High Productivity Controller Team Organisation
- Solution PJ.10-01b: Flight Centric ATC
- Solution PJ.10-01c: Collaborative Control
- Solution PJ.10-02a: Improved performance in the provision of separation
- Solution PJ.10-02b: Advanced Separation Management
- Solution PJ.10-05: IFR RPAS Integration
- Solution PJ.10-06: Generic' (non-geographical) Controller Validations

In 2019, the project activities have completed with the following results per solution:

- Solution PJ.10-01a: The solution has been split in two components: PJ.10-01a1 & PJ.10-01a2

  o The concept of MSP (1 PC – 2 ECs) in En-Route/eTMA (medium/high complexity) has reached V3 maturity and is ready for next step.

  o The concept of MSP in En-Route addressing a team structure with one MSP supporting more than two Executive Controllers (1 PC – 3 ECs) needs to be further investigated to prove the full feasibility and operational acceptability and to fully complete the V2 phase.

- Solution PJ.10-01b: Flight Centric ATC reached V2 maturity for areas that can be covered by a single VHF antenna in wave 1. For areas that cannot be covered by single VHF ground antenna, Flight Centric has not reached V2 in wave 1.

- Solution PJ.10-01c: The results have demonstrated the feasibility of the concept, with positive ATCO feedback on workload reduction thanks to a reduced need for coordination and communications improvement in situation awareness and no safety incidents through support offered by the new HMI design and tools.

- Solution PJ.10-02a: The solution has been split in two components: PJ.10-02a1 & PJ.10-02a2 are to improve and controller tools for improved performance within separation management. While PJ.10-02a2 makes us of ADS-C/EPP data, other trajectory data is used for 10-02a1.

  o Based on the obtained results, the improved separation management tools/functionalities of PJ.10-02a1 can work coherently together and are capable of delivering the required benefits and has reached V3 maturity.

  o Solution PJ.10-02a2 was operationally validated in En-Route environment. The validations conclusions indicated readiness of the MTCD enhanced with ADS-C/EPP data to move to V3 maturity phase.

- Solution PJ.10-02b: The solution validated advanced separation aids by providing new ATC assistance and more automated support tools, thereby advancing CD/R tools from information analysis to decision and action selection. The majority of exercises assessed the tools and concepts sufficiently to complete V1 maturity.

- Solution PJ.10-05: The validation activities performed in the context of 10.05 solution gave indications that the integration of RPAS flying IFR in medium complexity En-Route and TMA environment is feasible, but results achieved are not fully covering a V2 maturity solution. The expense of additional workload of the ATCOs with a consequent impact on airspace capacity was encountered, especially in the non-nominal conditions (e.g.: contingency procedures).

- Solution PJ.10-06: Results showed that, without additional support, Generic controllers found it difficult to plan traffic in an expeditious, efficient and safe manner within unfamiliar sectors. Initial feedback suggests there will be a trade-off between the improvement in cost efficiency due to more flexible ATCO rostering and the cost efficiency of individual controllers, which in turn means an impact on the Capacity KPA.

The project **PJ.11 CAPITO** 'Enhanced Air & Ground Safety Nets' addresses Current Airborne Collision Avoidance System (ACAS) performance requirements, which 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. The Project concerns the implementation and validation of a series solution:

- Solution PJ.11-G1: Enhanced Ground-based Safety Nets adapted to future operations,

- Solution PJ.11-A1: Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations – ACAS Xa,

- Solution PJ.11-A2: Airborne Collision Avoidance for Remotely Piloted Aircraft Systems – ACAS Xu,

- Solution PJ.11-A3: ACAS for Commercial Air Transport specific operations – ACAS Xo,

- Solution PJ.11-A4: Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp.

In 2019, the project activities have completed with the following results per solution The Solution PJ.11-G1 performed validation to prove whether STCA and NTZ ground-based safety nets, improved by means of Downlink Aircraft Parameters transmitted via ADS-B and Mode-S, obtain a better performance in terms of optimum alerting time and reduction of nuisance alerts. This solution reached V2 maturity level.

The Solution PJ.11-A1 Executed verification of ACAS Xa released version suitability for European airspace. The exercise was performed twice to remove some uncertainties. All along the project lifetime, coordination with the US teams took place to highlight possible improvements and the project team participated to the solution standardization taking place in RTCA / EUROCAE. The former title of PJ.11-A1 "Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations (ACAS Xa)". Has been change to "ACAS Xa European Acceptability Framework ". This solution reached V3 maturity level.

The Solution PJ.11-A2 performed progressive independent evaluations of ACAS Xu using European scenarios/encounter models and communicated findings to FAA/MIT in order for these to be taken into account for ACAS Xu evolution. This solution reached V2 maturity level.

The Solution PJ.11-A3 validated the technical feasibility and pilot's acceptability of ACAS Xo. Additional work is needed to reach the V2 maturity level and this solution is currently at V1 ongoing

The Solution PJ.11-A4 original focus was ACAS Xp (a version of ACAS X relying solely on passive ADS-B information). However, the scope of the project was changed to TSAA+. Eventually the solution reached V2 maturity level.

Optimised ATM network services

Under th**e 'Optimised ATM Network Services**' Key Feature, IR projects delivered the following:

The project **PJ.07 OAUO** 'Optimised Airspace Users Operations' focuses on flight planning supported by improved trajectory information sharing with ATM as defined in ICAO/FF-ICE and on flight prioritisation processes in capacity constraint situations–UDPP-, and on a step-wise integration of Military operations into civil ATM collaborative processes.

OAUO validates improved Airspace Users Flight/Wings Operations Centres' processes and tools for Trajectory Definition, Fleet Prioritisation and Preferences, and Mission Trajectory. Objectives include new performance indicators reflecting AUs' business needs in the ATM performance scheme; technology that drastically reduces the need for Airspace Users to perform labour intensive coordination; and integration of ICAO/ FF-ICE concept in the Trajectory Definition and UDPP processes.

Solution 07.01 Airspace Users' Processes for Trajectory Definition is about developing requirements and validating procedures and workflows for Flight Operations Centres, enabling them to interact better with other ATM stakeholders, especially with the Network Manager, with regard to (medium and short term) trajectory definition and Airspace User preference provision. This will also ensure continuity in the CDM process throughout the trajectory lifecycle. For this solution, all V1 documents are produced and approved. The main results from Solution 1 are the following:

- Regarding the clarification of concepts, it concerns in particular the following points:

  o DCB information and what-if functions need to be integrated with AU flight planning processes and systems in order to improve trajectory optimisation and enable automation of decisions.

  o Different types of hotspots need to be defined as shared information between flow managers and AUs in order to improve CDM processes and reduce the risk of network instability.

  o Regarding AU simple preferences as input to DCB processes, two types of flight delay criticality indicators (FDCIs) have been defined: Proactive FDCI issued for critical flights before any DCB measure is allocated and Reactive FDCI for corrective action by NMF to reduce the impact. Information flows and content as well as procedures and rules have been defined and fully agreed for reactive FDCI while some elements need to be defined yet for proactive FDCI.

  o Regarding reactive FDCI, the maturity is high since some existing procedures and system functions implemented by NM in operations can apply with limited adaptations. For the reactive FDCI, most of the validation questions have been addressed in the 07.01/09.03 iteration 2b exercise and this specific improvement can be considered of having achieved V3 maturity level, which was a quick win.

- Concerning performance assessment, the validation has provided the following results:

  o High benefits in terms of departure punctuality and AU cost-efficiency (in particular a 26% reduction of ATFCM delays in Winter period can be expected);

  o A slight degradation in terms of fuel efficiency (+37 Kgs per refilled flight, +0.006 kg per flight ECAC wide) and predictability KPAs due to the increase of flight plan changes to avoid DCB constraints. However, the results of the validation can be considered overall very positive since the impact is very limited (at least in nominal situations and out of highly constrained network situation like in Summer).

The Solution 07.02 Airspace Users' Fleet Prioritisation and Preferences (UDPP) is designed to smoothly integrate the priorities and preferences of airspace users via collaborative processes at airports and in Network DCB processes, allowing those processes to perform multi-criteria optimisation tasks involving many stakeholders. This solution will also address how airspace users who are not regular users at a given airport can use UDPP. The main results from Solution 2 are the following:

- The validation exercise based on the used prototyping tools has demonstrated that UDPP will bring benefits in punctuality and flexibility while maintaining equity between AUs, as well as providing substantial cost savings for the Airspace Users of up to 58% of the costs caused by ATFCM delays. UDPP is considered as operationally feasible by Airspace users and acceptable by Airport representatives although the limited scope made the exercise not fully conclusive.

- From this main validation exercise we can conclude that the UDPP for Airport Constraints (AUO-0109) has reached V2 level of maturity from the perspective of the airspace user operational feasibility and has validated to V2 the full autonomy delegation mode of DCB.

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- Operational acceptance and feasibility of UDPP was further demonstrated at a shadow trial exercise that took place at the SWISS airline OCC in Zürich for PJ25.

Concerning Cost/Benefit Analysis, the solution will provide the following benefits:

- o Considering the deployment of UDPP at ECAC-level of Operational Improvement (OI) Step1 AUO-0109 (UDPP for Airport constraints), the main benefit is the reduced impact of a regulation for airspace users (monetised in the CBA). Some of the other benefits are: a) improved passenger experience (fewer missed connections, fewer cancellations/diversions, fewer overnights due to curfew); b) improvement in punctuality; c) improvement in flexibility.

- o The CBA based on an average 40% reduction of the cost of additional ATFM delay extrapolated at ECAC level , has calculated a total Net Present Value of 192 M€ in 2035 with conservative assumption that the deployment would start in 2025.

The Solution 07.03 Mission Trajectory Driven Processes develops requirements and validate procedures and workflows for Wing Operations Centres, enabling them to interact better with other ATM stakeholders, especially with the Network Manager regarding the Mission Trajectory. In a first phase the focus will be on harmonising military flight plans and integrating military traffic intentions into the overall European ATM network. Solution 07.03 and Solution 18.01 are working together as one single project: the operational deliverables and the validation are managed by solution 07.03 and the technical and systems aspects are managed by Solution 18.01. The main results from Solution 3 are the following:

- Full V2 level of Maturity was reached for the full solution scope of PJ07.03 including all 6 Operational Improvements (OIs). For that purpose one last V2 validation exercise was executed as a follow up of SESAR I. The usability of initial Mission Trajectories for planning and execution of State Airspace User's Missions in the SESAR environment and the exchange of related data as iOAT FPL between WOC, Regional ATFCM and En-Route/Approach ATS could be successfully demonstrated. The focus of this last validation exercise was on the execution phase as a Real-time Simulation. The exercise demonstrated feasibility of the operational processes and technical systems to support Mission needs with the iOAT FPL.

- An important first step on the road towards V3 level of maturity has been taken with the successful execution of a first V3 exercise. In this first exercise, the technical and operational feasibility of planning Mission Trajectories using the improved (iOAT FPL) was successfully demonstrated. The improved Operational Air Traffic Flight Plan shall generally be fully compliant with the complete set of ATM Network rules and restrictions, without compromising military mission needs. Where this is not possible without compromising mission requirements, the use of existing Exemption Mechanisms was successfully validated. In addition, this exercise has proven that it is technical feasible to integrate the Mission Trajectory via iOAT FPLs in the regional (NM) and sub-regional/local (FMP) ATFCM systems.

Concerning Cost/Benefit Analysis, the solution will provide following benefits:

- Compliance to the RAD should decrease the complexity for the Network Manager (NM) & Air Traffic Control (ATC) units due to the reduced complexity of OAT and GAT (General Air Traffic) trajectory interactions.

- Military flight planning efficiency will increase through information sharing and the full integration of Military Wing Operation Centres (WOC) in the overall Air Traffic Management.

- Sharing of the full military trajectory should lead to some predictability improvements on the civil side. This additional level of awareness could also reduce associated capacity buffers and provide a small increase in capacity.

The project **PJ.08 AAM** 'Advanced Airspace Management' focuses on Dynamic Airspace Configurations (DAC) and Dynamic Mobile Areas (DMA). Compared to today's airspace scenarios, which by their nature are static, DAC/DMA enable flexible solutions that can be dynamically adapted to traffic demand to respond to different regional/local performance objectives, which may vary in time and place. AAM Partners elaborate the definition of DAC/DMA, the associated data models and operational processes, validate the operational feasibility and assess the performance impact. The readiness for integration of the DAC operational process in the DCB process is also addressed. Automated tools to generate optimum sector design and configurations, as well as DMA optimal location and volume to meet performance targets are developed. AAM supports the SESAR Deployment regulation and addresses European concerns on economic (more efficient use of ATM Network resources) and environmental sustainability (reduced fuel burn and emissions) of Air Transport system.

Solution 08.01 – Management of Dynamic Airspace Configurations: This SESAR Solution was defined to develop the process, procedures and tools related to Dynamic Airspace Configuration or DAC management, supporting Dynamic Mobile Areas of Type 1 and Type 2, through:

- En-route ATC sectors design and sector configurations principles based on 4D trajectories forecast, enabling a seamless and coordinated approach for airspace configurations from planning to execution phases, increasing the Network capability to continuously adapt to demand pattern changes and traffic flows volatility induced through the extensive implementation of free route operations

- The activation of Airspace configurations through an integrated collaborative decision making process, at national and regional levels. Procedures and system support tools (also based on Artificial Intelligence techniques) have been developed to enable the management of the airspace configurations as a continuum to meet the users' expectations (civil and military airspace managers, flow managers)

- En-route ATC sectors configurations aiming at adapting to dynamic TMA boundaries and both fixed and dynamic elements (i.e. fixed and flexible routing, reserved/restricted airspace (ARES, CBA, CBO, DMA)).

The main findings from the overall validation exercises can be summarised as follows:

- Civil and Military Coordination: Military operational training capabilities remain unchanged with the application of DMA principles. The CDM processes provide opportunities to reduce transit times in military missions by 17min. The impact on the civil traffic rerouting is reduced when using DMA Type 2, there is a decrease in the total number of impacted flights compared to static ARES and a gain (in terms of distance, fuel and time) also for individual flights

- Operational feasibility: The concept was recognised to enhance predictability & flexibility, representing therefore an improvement to today's operations. In general, all actors confirmed their preference for the decentralized model. One exercise provided evidence of the operational feasibility of the DAC principles for dynamic sectors configurations (within the INAP time horizon), with a high level of acceptability by the operational actors. One major outcome was the considerable time saving thanks to the automated tool in detection, resolution and decision making for the management of sectors configurations. Operational feasibility of the ATC

operational procedures in an environment without predefined sector configurations was confirmed.

- o Exercise PJ.08-01 VP-08-01.04 (DMA type 2 performance assessments in FRA airspace through a gaming experiment using R-NEST and AirTOp simulators) is completed.

- o Exercise PJ.08-01 VP-08-01.05 Execution (Operational feasibility of the DAC concept for FMP till INAP time horizon, with human in the loop, by expert judgement- Operational acceptance and relevance of DAC services to support sectors configuration optimization process.- Technical feasibility and operational assessment of airspace design generated using a flow centric approach)

- o Exercise PJ.08-01 VP-08-01.06 Execution (TAT Session + OAT Training + RTS) (evaluation of DAC concept from the ATCOs perspective) is completed.

Solution 08.02 – Dynamic Airspace Configurations supporting Moving Areas: the objective of this Solution was limited to a study of the currently available METEO information to analyse how this data feeds could supply specialised tools that would predict the moving hazard zones. The result of this work was to extend the DAC solution to the support of Dynamic Moving Areas and Moving Hazard Zones. (Moving Hazard Zones) Study Report: Moving Hazard Zones Study Report provided the results of the development conducted in the Solution. Preliminary V0-V1 Moving Hazard Zones concept was developed as a part of SESAR Solution PJ08-02. That document also contains the envisaged operational setup of the Moving Hazard Zones concept, process automation concept and preliminary definition of other operational characteristics.

The project **PJ.09 DCB** 'Advanced DCB' evolves the existing DCB process to a powerful distributed network management function, which takes full advantage from the SESAR Layered Collaborative Planning, Trajectory Management principles and SWIM Technology to improve the effectiveness of ATM resource planning and the network performance of the ATM system in Europe.

- Solution 09-01 – Network Prediction and Performance develops shared situation awareness with respect to demand, capacity and performance impacts. Traffic and demand forecast have improved reliability based on complexity assessment and the computation of confidence indexes. Network Operations will be continuously monitored through Network Performance KPA/KPI to facilitate collaborative decision making processes. The main findings from the overall validation exercises can be summarised as follows:

- o The probabilistic demand prediction method based on time error (uncertainty) developed the preparatory activity has demonstrated to be a viable step forward in the effort to improve traffic demand prediction in the Network. The methods developed for demand prediction and probabilistic counts showed positive results when comparing the probabilistic forecast against the actual counts. The ability to detect overloads correctly has been proved.

- o The complexity prediction results demonstrated that the Complexity prediction method based on Cognitive Complexity was a promising tool for FMPs. The Cognitive Complexity indicator was considered as the most promising complexity indicator and its calibration has been automatized.

- o The use of a simplified Complexity algorithm, weighted density forecast, by the FMPs in the validation exercise demonstrated high interest in Complexity information. Common agreement was made regarding the improvement of situational awareness and decision making process.

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- o From the performance monitoring perspective, the consideration of impacted stakeholders' performance indicators in the selection of candidate flights for DCB measure was appreciated among all the participants (FMPs, AUs and APT) in the validation exercise. The performance indicators provided helpful information, improving the situational awareness on the negative impacts of DCB measure.

- Solution 09.02: Integrated Local DCB Process forms the core functionality of the INAP process (everything which can and should be decided locally. Solution PJ.09-02 is the logical follow-up of the SESAR1 Local DCB toolset. It includes: INAP management, ASM integrated into DCB, reconciliation of DCB measures with local complexity management, ATC and Arrival Management. The solution addresses the integration of Local Network Management with extended ATC planning and arrival management activities in the short-term to execution in a seamless process. The most significant results obtained by Solution 02 as regards the integration of Local DCB Processes can be summarised as follows:

  - o Reduced need for regulations on high-demand periods. Obtained through the use of coordinated STAM supported by specific Local tools. Confirmed in the validation by Local Traffic Managers

  - o A human centred design facilitates STAM solution implementation. The validation results show that workload is either reduced or maintained, and that it is possible for the Local Traffic Manager to identify ahead of time the impact of a proposed STAM through the use of dedicated what-if tools.

  - o Automation supports and enhances the effectiveness of STAM. Automation supports decision-making based on the provision of the right information at the right time. The use of advance dashboards and of the Local Tools, allows for structured information.

  - o Air Traffic Complexity is a useful tool to optimise Capacity. It facilitates decision-making, provides insight into prediction and increases the common situational awareness.

- Solution 09.03: Collaborative Network Management delivers subsidiary Network Management facilitated by a rolling NOP planning environment (including weather, demand pattern and capacity bottlenecks). Network Operations planning and Execution is managed by an agreed set of rules and procedures, guiding subsidiary DCB and UDPP measures under consideration of trade-offs and network performance targets. Collaborative 4D constraints management integrates AUs priorities and reconciles DCB measures with Airports, ACCs, AU and NM. Conclusions derived from PJ09.03:

  - o Pro-active FDCI and AOP/NOP TTA information integrated in eFPL, related to the OI DCB0103-B, needs some tools and process refinements that requires the validation work to continue, achieving at the end a partial V2 maturity level.

  - o Network stability, in relation to the OI DCB-0217, needs still some work and testing in summer traffic conditions. While being mostly at V2 level, it do not prevent the OI DCB-0217 to be at the targeted V2 maturity as a whole.

  - o The DCB Collaborative Framework, related to the OI DCB-0215, has shown operational acceptance and feasibility for the concept but needs the work on V2 to carry-on, achieving only a partial V2 maturity level.

  - o Some topics related to this solution reached a higher maturity level than planned:

o Flight Delay Criticality Indicator (FDCI) reactive mode and AOP/NOP departure information integrated in eFPL, related to the OI DCB-0103-B demonstrated strong maturity along the validation. We consider them as V3 maturity level

o Constraint reconciliation, related to the OI AUO-0108, with the refinement on ATFCM slot allocation proposed by the ECASA improvement strategies, reached the V2 maturity level and is ready to continue V3 validation

Enabling aviation infrastructure

Under the '**Enabling ATM Infrastructure**' Key Feature, IR projects delivered the following:

The project **PJ.14 EECNS** 'Essential and Efficient Communication Navigation and Surveillance Integrated System' is an Enabling Infrastructure project that aims at providing an advanced, integrated and rationalised aviation infrastructure for Communication, Navigation and Surveillance (CNS). It provides the underlying technical capabilities to meet the required operational improvements in support of Optimised ATM Network Services, Advanced Air Traffic Services and High-Performance Airport Operations key features.

The 11 solutions addressed by PJ.14 EECNS cover:

- Solution PJ.14-01-01: CNS Environment Evolution will provide an integrated, global view of the future Communications, Navigation and Surveillance services. This would include: The evolution, Strategy and Roadmap for an Integrated CNS; Identify current CNS requirements; Assessing cross-domain CNS vulnerabilities; Identifying short-term and long-term CNS evolution for both ground and airborne system; Defining the future integrated CNS architecture; Defining the integrated CNS spectrum strategy; Identifying areas where the CNS efficiency could be improved; Ensure Civil-Military CNS interoperability.

- Solution PJ.14-02-01: FCI Future Terrestrial Data Link has the objective to develop and standardise the candidate future terrestrial data link system LDACS. The goal of this solution is to finalize the development and standardization of the LDACS technology. This includes security and digital voice concepts, and will contribute to the development of a harmonized global standard.

- Solution PJ.14-02-02: Future Satellite Communications Means (data link) is focused on the near and long satellite data link technologies for both continental and oceanic regions. It will also include digital voice as an element of the Future Communications Infrastructure (FCI). The main objectives include: Compliance with ATN baseline 2 requirement (especially Real time sharing of 4D trajectories); Development of technical specifications and validation procedures for Long Term SATCOM for ATM/Iris (class A SatCom) integrated in the FCI (IPv6 and ATN/IPS with multilink policy) and taking into account a seamless transition from SESAR baseline and considering the intermediate step of the i4D based on ESA Iris Precursor solution (Class B); Technical validation of satellite Air-Ground Datalink for Long Term SATCOM integrated in the FCI (ATN Baseline 3, ATN/ IPS, multilink); Standardization at global level (ICAO, EUROCAE) of proposed solution for Long Term SATCOM; validation to V2 in wave 1 followed by V3 validation in wave 2. There will be strong coordination with ESA Iris Programme and the reuse and consolidation of the ESA Iris programme prototypes where possible

- Solution PJ.14-02-04: FCI Network Technologies incl. voice solution and military interfacing seeks to develop and standardise the FCI elements that integrate all the future terrestrial data link

systems. LDACS, SatCom and AeroMACS, delivered respectively by solutions PJ.14-02-01, PJ.14-02-02, and PJ.14- 02-06. In addition, this solution will address transversal topics including security, safety, and civil- military interoperability with ground/ground communications networks. The solution will demonstrate support of symmetric communications via multi-link to a mobile end system (e.g. airplane) by means of LDACS, AeroMACS, and SATCOM data links. This will be validated by demonstration of 4D-trajectory based/sector-less operation in both laboratory and (emulated) mobile environments.

- Solution PJ.14-02-05: Development of new services similar to FIS-B to support ADS-B solutions for General Aviation. The solution will investigate suitable means to provide supplementary information for GA and thus, to increase safety particularly in mixed traffic environments. This includes the use of an appropriate infrastructure (3G/4G/5G) as well as the bundling and provision of additional services (FIS [Weather/NOTAM/etc.] and TIS) to GA.

- Solution PJ.14-02-06: Completion of AeroMACS Development. The primary objectives of this activity are to integrate and verify the AeroMACS Data Link with ATN services, both at ground and on-board. Initially ATN/OSI will be considered, while ATN/IPS will be verified subsequently, in line with the ICAO roadmap. The AeroMACS A/G datalink will also be integrated with the multilink environment, with the definition and potential implementation handover from AeroMACS to VDL2 during take-off, and vice-versa during landing. The Network and Security System requirements will be finalised, also in relation to multilink. A digital voice communications solution over AeroMACS (VoIP) will be finalised and verified. The solution will also support the standardization process providing input to, and aligning with, the relevant standardization activities in ICAO, EUROCAE/RTCA, AEEC, ETSI, and WMF. AeroMACS is expected to reach a V3 maturity level within Wave 1.

- Solution PJ.14-03-01: GBAS. The objective is to advance GBAS as a technical enabler and to take advantage of the operational benefits that GBAS can provide. The operational benefits include: Capacity increase in low visibility conditions; Shorter routes and fuel-saving approaches, providing cost-savings, less emissions and noise; Provide precision approach on runways where ILS is not feasible

  o The GAST D-related activities in PJ.14-03-01 aim to further mature GBAS to address conditions outside the mid latitudes, to meet the requirements of a globally deployable system. It will also develop and validate the infrastructure needed for operations on complex airports.

  o The plan for the GAST F activities is to provide initial standards to address multi-constellation/multifrequency GBAS, to provide enhanced robustness, especially against challenging aspects of the ionosphere environment.

- Solution PJ.14-03-02: Multi Constellation / Multi Frequency (MC/MF) GNSS. The objective of solution is the maturation of the framework and the technical enablers so that GNSS receivers processing any constellation(s) in Multi Frequency can be developed to support the different foreseen expectations from the deployment of GNSS navigation taking profit of multiconstellation (GALILEO) and multifrequency. The operational benefits remaining to be identified shall be further assessed, but it is expected that MC/MF GNSS/SBAS would contribute to support: PBN; Approaches with horizontal and vertical guidance; Surveillance (ADS-B); 4D concepts; Autoland capability; Lower minima SVGS operations; Surface movement; Ground infrastructure rationalization.

- Solution PJ.14-03-04: Alternative Position, Navigation and Timing (A-PNT). The objective is to develop an A-PNT system as a technical enabler to support PBN/RNP operations in case of a GNSS degradation or outage. The solution aims to provide both a feasible short term solution and a long term improvements to support more demanding operational positioning and navigation requirements.

    o The short term work will seek to enhance legacy technologies (e.g. DME, IRS), and hence make use of existing infrastructure and equipage.

    o The medium term will investigate the possibility to improve DME based localization algorithms in the airborne FMS to fully support the OBPMA integrity requirements defined for a RNP navigation specification in the PBN manual.

    o For the long term upgrade, new technologies (e.g. LDACS, eLoran) will be studied. A goal will be to improve the performance while increasing spectrum efficiency and creating synergies.

- Solution PJ.14-04-01: Surveillance Performance Monitoring. The objective is to enable a harmonised performance monitoring of surveillance systems. Such monitoring will seek to identify degradation trends early, using both off-line and in continuous quasi real-time processes. The specification of surveillance performance monitoring tools supporting both Cooperative and Non- Cooperative surveillances techniques are addressed by this Solution (Ground-based and Space-based, ADS-B, WAM, MLAT, SMR), covering en-route, TMA and Airport surface and the surveillance monitoring performance will be applied both at sensor level and at the output of the entire surveillance chain ("End-to-end"). The solution targets at the end of wave 1 Maturity V2 for Cooperative Sensor level (WAM, ADS-B and MLAT) and V1 for Non-Cooperative Sensor level and "End-to-end".

- Solution PJ.14-04-03: New use and evolution of Cooperative and Non-Cooperative Surveillance. The objective of this solution is to address the separate evolution of non-cooperative surveillance systems like MSPSR and Video Trackers, and cooperative surveillance systems such as ADS-B, Airport and Wide Area Multilateration (MLAT/WAM) systems. New systems like MSPSR, and additional functionalities for cooperative sensors, such as security screening and reporting methods will be demonstrated in real environments. Evolution of ADS-B datalink and the exchange of data between sensors, and composite surveillance are planned to improve sensor ambiguity resolution performance. A dedicated task will adapt multi sensor tracker systems for the new input data characteristics and implement additional functionalities on multiple platforms. The solution will demonstrate the achievement and proposed improvements using one or more prototypes in real environment.

In 2019, the activities performed in PJ14 CNS have been developed at European Level in order to avoid a fragmented approach and to ensure the interoperability as depicted in the ICAO Global Air Navigation Plan (GANP).

- Solution PJ14-01.01 iCNSS - Evolution, Strategy, roadmap and Spectrum, provides the "CNS evolution strategy & roadmap" and addresses the evolution of CNS applications with an integrated view of the three domains, Communication, Navigation and Surveillance, whilst also considering spectrum efficiency aspects (i.e. iCNSS). In addition, it provides initial versions for the integrated performance approach and robustness analysis.
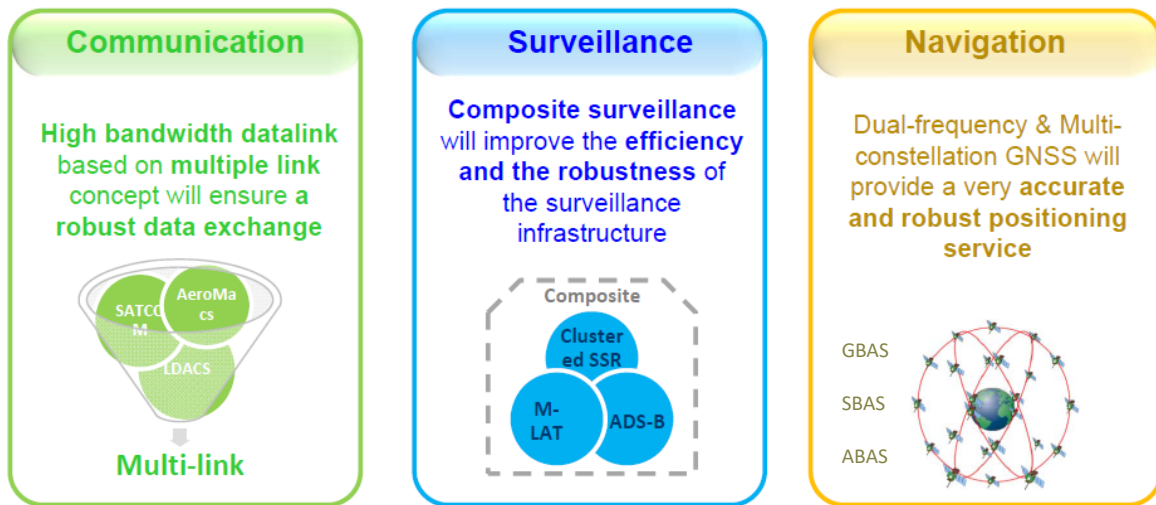
Figure 12: CNS & PJ14 solutions

Communication Domain

With an objective to provide ATM through to Airspace Users with the digital communications means required to cope with the forecast traffic growth, the Future Communication Infrastructure (FCI) concept has been further developed through the use of multilink technologies.

- The transversal solution PJ14-02-04 achieved an overall Technical Readiness Level 4 (TRL4) maturity level, demonstrating support of symmetric communications addressing Terrestrial, Satellite and Airport datalinks within a multilink environment to a mobile end system. It integrates the prototyped and technically validated concepts of LDACS, SATCOM and AeroMACS.

- Solution PJ14-02-01 with the Terrestrial System L-band Digital Aeronautical Communication System (LDACS), which provides two different communication possibilities:

  - Air/Ground datalink using ATN/IPS reaching TRL4. Technical feasibility of this terrestrial system is demonstrated through technical validation of prototypes against the required performance levels.

  - Air/Air Functionality of the LDACS A/G radio reaching TRL2. Functional requirements have been defined for the system to support mid-air communication between different aircrafts.

- Solution 14-02-02 with the long-term Satellite Communications System (SATCOM Class A), reaching TRL4. It provides an IPS based datalink technology ready to support both continental and oceanic regions.

- Solution PJ14-02-06 with the Aeronautical Mobile Airport Communication System (AeroMACS), reaching TRL6 in a multilink context. Successful integration of AeroMACS with ATN/OSI and ATN/IPS networks in both stand-alone and multilink contexts, together with support to Digital Voice communications, conclude that AeroMACS is ready to be completely rolled-out by the European ATM stakeholders. It was noted that there was a risk of losing the spectrum allocated to AeroMACS in the coming years if not used.

- As a complement for the communication domain, solution PJ14.02.05 has investigated suitable means to provide flight and traffic information to General Aviation pilots in order to increase safety in mixed traffic environment. The solution has reached V2 maturity level.

Navigation Domain

The vision of the Navigation domain solutions is to improve all phases of flight with suitable integrity, continuity and availability to support the evolution of Air Traffic. Satellite navigation based robust positioning has been developed for all phases of flight, taking advantage of signals from dual frequency and multiple constellations such as GALILEO with different types of augmentations. The emphasis has been on the provision of 3D Approach guidance targeting the lowest approach minima. The navigation solutions development are as follow:

- PJ14-03-01 has investigated GPS Single Frequency Ground-Based Augmentation System (GBAS) and Dual Frequency GPS and GALILEO GBAS. The objective behind the solution PJ14.03.01 was to advance the GBAS Approach Service Type D (GAST-D) concept, currently TRL6, to address "Extended Scope", namely Complex Airports and Extended to High/Mid Latitudes reaching TRL4 and "Extended Service Volume (ESV)" reaching "TRL6 ongoing" at the end of Wave 1. The target maturity of GBAS GAST F at the end of Wave 1 has been "TRL4 on-going" through the Consolidation of the GAST-F Concept and related specifications

- PJ14-03-02 solution has investigated Dual Frequency Multi Constellation augmented by Aircraft-Based Augmentation System (ABAS) and Satellite-Based Augmentation System (SBAS). In parallel, evolution of terrestrial navigation systems has been explored, to ensure that resilient performance based navigation services are available to mitigate the vulnerabilities of satellite navigation. The solution has achieved the TRL4 maturity contributing to a significant number of SESAR Operational Improvements.

- PJ14-03-04 solution investigated short, medium and long term Alternate Positioning Navigation and Timing (A-PNT) services finalized to provide efficient navigation during Global Navigation Satellite System (GNSS) outages. It achieved the objective to mature at different levels the following areas:

  o A short-term A-PNT solution relying on the assumption that most of current aircraft DME/DME navigation can support RNP 1 reversion without any modification in the avionics, if the ground infrastructure provides a required level of integrity, and if the flight crew is appropriately trained. The DME/DME solution achieved TRL6.

  o A mid-term A-PNT solution that has explored the capability to fit multi-DME positioning in the existing FMS with RAIM algorithm to fully comply with RNP requirements involving On-Board Performance Monitoring Alerts (OBPMA) features, for the continuation of RNP1 operations in case of GNSS loss, without any operational impact from flight crew or ATC perspective, and using existing DME ground infrastructure. The multi DME positioning solution achieved TRL4.The long-term A-PNT solution builds on new technologies currently not available on board the avionics (LDACS as a navigation system, eDME and eLORAN) to define the functional requirements of the future A-PNT system. This future A-PNT achieved TRL2.**Surveillance Domain**

The Surveillance domain envisions enhancing, harmonizing and integrating cooperative and emerging non-cooperative sensors, advanced multi-sensors data fusion capabilities, security related functionality together with enhanced Surveillance Performance Monitoring (SPM) tools.

- Solution PJ14-04-01 addressed the adaptation of SPM methods and tools to take into account the evolution of the emerging standards for the development of a quasi-real time functionality to monitor the surveillance performance at:.

- o Sensor level, for both cooperative and non-cooperative surveillance. The successful integration of the system requirements into four different SPM prototypes has been demonstrated achieving TRL4 maturity.

- o End-to-End level (covering the whole surveillance chain): functional requirements have been defined and validated, allowing achievement of TRL2 maturity.

- Solution PJ14-04-03 addressed the evolution of non-cooperative surveillance systems. The include Multi-Static Primary Surveillance Radar (MSPSR), Video Trackers and cooperative surveillance systems such as Automatic Dependent Surveillance-Broadcast (ADS-B), Airport and Wide Area Multilateration systems in multiple fronts: composed surveillance systems (i.e. cooperative surveillance + ADS-B and non-cooperative surveillance + ADS-B); multi-sensor data fusion; a new surveillance system for multi remote tower operations; enhanced security functionalities to ensure safe ATM operations; and the phase modulation for ADS-B and Mode S. An overall maturity of TRL4 has been achieved for all these features.

The project **PJ.15 COSER** 'Common Services' completed all work end 2019 and this concerns the implementation and validation of a series of independent common services solutions. A Common Service is a service that provides a capability to consumers in the same way that they would otherwise need to provide themselves. As a natural consequence, this approach ensures the delivery of such functionalities with an improved cost effectiveness, which should in turn benefit the whole European ATM Community.

The following common services were further developed and validated in 2019:

- **PJ.15-01. Sub-Regional Demand Capacity Balancing Service:** the service focuses on the sub-regional element of the Network Management Function (NMF), supporting planning and execution time frames with the objective of validating the cost benefits of Common Service supply to multiple consumers. It achieved TRL 6 level maturity at the end of 2019

- **PJ.15-02. E-AMAN Service : the service** provides functions necessary to operate Arrival Management with an extended horizon (XMAN, Cross Boarder Arrival Management) in an environment where multiple actors are involved e.g. multiple Airports, Arrival Managers (AMANs), Air Control Centres (ACCs), Upper Area Centres (UACs) and Network Manager(NM). It achieved TRL 6 level maturity at the end of 2019

- **PJ.15-08. Trajectory Prediction Service:** Fundamental SESAR concepts rely upon a consistent and appropriately accurate view of trajectories being presented to various geographically separated actors in varying time frames. The Trajectory Prediction Service solution aims to define the minimal set of features that enabled the essential interoperability without unnecessarily restricting implementation. In 2019 some progress was made to further refine the solution but it did not yet achieve the targeted TRL 2 maturity.

- **PJ.15-09. Data Centre Service for Virtual Centres:** The Virtual Centre Concept aimed to the geographical decoupling of the ATM Data Service Providers (ADSPs) from the Air Traffic Service Units (ATSUs). In 2019 Operational Requirements for the Delegation of the provision of Air Traffic services between ATSUs and Contingency were developed in close cooperation with PJ.16-03 solution that on its turn developed a concept for separating the CWP from the data centre where the data is produced. At the end of 2019 the Operational Requirements were assessed to be at the level of maturity V1.

- **PJ.15-10. Static Aeronautical Data Service:** This solution provided a service to provide static aeronautical data in digital form to be used by different ATM systems. The output is an AIXM-compliant dataset whose subsets can be retrieved by individual requests demanding specific geographical areas, attributes or functional features. At the end of 2019 the service was assessed to be at TRL 6 level maturity.

- **PJ.15-11. Aeronautical Digital Map Service:** The Service collected aeronautical data from authorised sources, filtered them and produced individual graphical maps depending on the specific usages as geographical area or system functionality. In this sense, configuration management tools should be implemented to better satisfy the consumers requirements. It achieved TRL 6 level maturity at the end of 2019

The project **PJ.16 CWP/HMI** completed work end 2019 which concerns two distinct and independent solutions:

- **Solution 16.03 - Virtual Centre**: researching the technical capability to transfer data between geographically separated data service providers and ATSUs using interoperable services and (to-be) standardised service interfaces. In 2019 work was concluded by development and technical validating a concept for separating the Controller Working Position (CWP) from the data centre where the data is produced. This lean and efficient use of ANSP infrastructure tackles the issues presented by fragmented European ATM systems and country-specific architectures, enabling Europe to move to an interoperable, cost effective and flexible service provision infrastructure. Decoupling of the CWPs should enable a more efficient use of the most valuable and expensive resource, the human. By enabling increased flexibility, the ANSPs are able to better manage staffing for prevailing traffic conditions and assure service continuity. By doing this the solution delivered to the SESAR JU concrete results at the level of TRL 6 as an agreed definition of the concept, a target architecture recognised by the ATM community, a definition of ADSP services. It has also provided a clear technical input for the recently finalised Airspace Architecture Study (AAS) mandated by the European Commission.

- **Solution 16.04 - HMI CWP:** brings together a series of various HMI CWP technologies & improvements and has dealt with new methods of Controller interaction with the Human Machine Interface (HMI), applying mature technologies from other domains to ATM. All this with the aim to increase controller productivity, reduce workload, stress level and enable the use of SESAR advanced tools to safely facilitate performance based operations. The maturity of each of the sub solution as concluded at the end of 2019 could be summarised as follows:

  o Multi Touch Inputs (MTI) : TRL 4 and considered as ready for industrialisation

  o Automatic Speech Recognition (ASR) : TRL 4

  o Attention Guidance (AG) : TRL 4

  o User Profile Management Systems (UPMS) : TRL 4

  o qualification of CWP Virtualisation (CWPV). : TRL 4

The project **PJ.17 SWIM-TI** 'SWIM Technical Infrastructure' (SWIM) relies on a network of SWIM nodes (also called 'ATM intranet') which dramatically reduces the number of interfaces, decouple the information providers from the information consumers, and capitalize on open standards. At the SWIM

nodes, SWIM-enabled applications use interoperable services to exchange information conveyed through a SWIM Technical Infrastructure (SWIM-TI) middleware based on an IP-based network.

The three PJ.17 solutions build on the SESAR 1 results to extend the SWIM-TI (which will be a key communication enabler for other SESAR 2020 solutions) include:

- PJ.17-01 "SWIM-TI Purple Profile for Air/Ground Advisory Information Sharing" will support ATM operational improvements that depend on Air/Ground (A/G) information exchanges to enable a better situational awareness and collaborative decision making, with a focus on advisory information. The targeted maturity level in wave 1 is TRL6. The Data Pack will be made available to the SESAR Deployment Manager to complement the initial European SWIM Infrastructure (iSWIM) components. This will enable in particular operational applications to uplink meteorological or aeronautical information using SWIM. Solution PJ.17-01 will also anticipate the Air/Ground Safety-Critical Information Sharing ("Feasibility Study for Air/Ground SWIM for Safety Critical Information sharing (PJ.17-07)) task". This objective was not applicable in this reporting period (introduced in the 2nd Grant Amendment).

- PJ.17-03 "SWIM-TI Green Profile for G/G Civil Military Information Sharing "will focus on the evolutions to be implemented and the constraints (e.g. in the cyber-security area) to be taken into account for connecting SWIM networks used by the civil ATM community to military networks. The interconnection of these networks will contribute to increase collaboration between the civil ATM community and the military stakeholders, as pointed out in the European ATM Master Plan. PJ.17-03 contributes to the interconnection of the civil and military domains on top of the civil IP network infrastructure, therefore at middleware level (transport and application messaging). The targeted maturity level in wave 1 is TRL4. This TRL4 Data Pack will become the first baseline technical specification for SWIM systems supporting civil-military communications.

- PJ.17-08 "SWIM-TI Common Runtime Registry" will extend the work done in SESAR 1 on the Design-Time Registry to the Runtime Registry which is needed for late binding to SWIM services, provision of routing information to SWIM services, provision of SWIM service status information and lookup of policies. The targeted maturity level in wave 1 was modified from TRL6 to TRL4 (partial) due to the need for operational requirements and closing early 2019, with an associated release of budget. A Technical Specification and OSED will be available within the Data Pack.

In 2019, PJ.17 extended the SESAR 1 R&D by focusing on the three following parts of the SWIM-TI:

- Air/Ground Advisory Information Sharing: PJ.17-01 solution and PJ.17-07 feasibility study task,

- Ground/Ground Civil Military Information sharing: PJ.17-03 solution,

- Common Runtime Registry: PJ.17-08 solution.

For each of the first two parts, a set of interoperability requirements corresponds to a "SWIM Profile".

- PJ.17-01 - SWIM-TI Purple Profile for Air/Ground Advisory Information Sharing has addressed the SWIM technical infrastructure that enables the integration of the aircraft into the SWIM network, thus giving it access to air/ground advisory SWIM services. The solution started from the beginning of TRL4 and has reached TRL6 in two cycles by.

- This has successfully demonstrated the technical feasibility of the SWIM Purple Profile (technical architecture, technical use cases, reliability, security and Quality of Service), and pointed out that the overall performance is closely depending on the deployment options.

- Recommendations for the next steps (from TRL7 onwards) have been identified with regard to the assessment of performance, security management, deployment options, interface with external systems, human factors analysis, and airworthiness evaluation.

- PJ.17-07 - Feasibility Study for Air/Ground Safety Critical Information exchange has demonstrated that the Air-Ground SWIM for safety-critical information sharing should be built on top of the SWIM-TI Purple Profile for Air/Ground Advisory Information Sharing (reuse, specialization, etc.). The results will be valuable inputs for the Wave 2 TRL2 activities, for which it is recommended:

  o to refine and complete both functional and technical viewpoints,

  o to address the avionics architecture as part of the technical viewpoint,

  o to perform initial safety and security assessment.

- PJ.17-03 - SWIM-TI Green Profile for G/G Civil Military Information Sharing started from TRL0 through to TRL4. The solution demonstrated the technical feasibility of the Green Profile at lab level and its positive contribution to relevant KPAs.

- Taking into account the Military expectations and the European ATM Master Plan 2015, the solution concluded that the Green Profile will be extensions of existing G/G SWIM profiles to support military specific needs, limited to Yellow Profile in Waves 1 and 2. The main military expectations consist in more security, more resilience, the support of exchanges on military sensitive data, and when necessary the right level of performance in terms of capacity (latency, throughput).

- The solution has reached TRL4, thus enabling to undertake TRL6 activities in the next R&D phase, which should demonstrate the GP ability to run in a close-to-real-world environment, hence taking into account its integration with civil and military SWIM-enabled applications, and infrastructure services such as PKI and IP network infrastructure(s).

- PJ.17-08 - SWIM-TI Common Runtime Registry started out from TRL0 by collecting and defining the functional requirements for a SWIM runtime registry. Nevertheless the solution suffered from a lack of operational requirements and had to extend its original scope by also elaborating them. This work revealed that the real value of a runtime registry for operational purposes was not so much the ability to dynamically search for suitable services and bind to them during runtime. Rather the knowledge of the operational status of a service proved to be the main operational need.

- Due to budget limitations on the programme, the solution was descoped to only a partial TRL4 maturity cycle concentrating on delivering an updated technical architecture of the SWIM Registry. The distinction into a design-time and a runtime registry has been replaced by an integrated view of one registry system that contains static and dynamic information used to serve different purposes. It introduced two fundamentally new functionalities (criteria-based search, and service status handling), and proposed three registry technical implementation architecture options.

- The work done in the solution leads to recommend that the suspended work resumes as part of a next R&D phase in order to achieve full TRL4

The project **PJ.18 4DTM** '4D Trajectory Management' deals with several different and independent types of solutions all related to 4D Trajectory Management: long term ATM Solution such as Trajectory Based Operations (TBO – Solution 18-02a) as well as various technological Solutions (such as Interoperability, Aeronautical Information Management, Meteorology or Enhanced Trajectory Predictor) are progressed towards various maturity levels.

In 2019, the following activities progressed as follows:

- Activity 18-01a (Initial Mission Trajectory) supported Solution 07-03 validation exercises and finalised its Technical Specification to support Solution 07-03 maturity gate;

- Activity 18-01b (Mission Trajectory Based Operation) aimed at supporting the transition of the initial Mission Trajectory executed, represented by Military Transport A/C type with enhanced airborne capabilities into the Trajectory Based Operations (TBO) environment. The activity performed one validation activity and consolidated its results to support Solution 18-02a V1 Maturity Gate;

- Solution 18-02a (Trajectory based Operations) achieved V1 Maturity gate; The solution focussed on the Reference Business Trajectory (RBT) management and the last phase of Shared Business Trajectory (SBT), once flight plan filing has occurred. The Solution contributed to maturing elements that will be used to provide European input to the development of FF-ICE/2 at ICAO level.

- Solution 18-02b (Flight Object Interoperability) ran its first exercise in April 2019 and passed the Go/No Go criteria which allowed to continue the work towards Exercise 2 preparation in 2020; IOP is a key enabler facilitating the introduction of the RBT concept, the Flight Object (FO) Interoperability (IOP) is the mechanism that allows seamless trajectory exchange between ATSUs, especially for the Coordination and Transfer phase between ATSUs.

- Solution 18-02c (eFPL distribution to ATC) passed TRL6 Maturity Gate after completion of last set of exercises and consolidation of the necessary Datapack. The Solution looked at the distribution and use of eFPL information to ATC systems, that could potentially facilitate the improvement of the alignment of NM's and ATSU's trajectories.

- Solution 18-04a (Aeronautical Information Management information) supports other ATM operational solutions by developing their information services. PJ.18-04a delivered three information services in the domain high performing airport and ATM network services, which were validated by PJ.03a-04, PJ.09-02 and PJ.24 operational solutions. The solution will be completed in 2020 aiming to achieve TRL6 maturity level.

- Solution 18-04b (Meteorological information) defines and delivers technically validated MET Information Services and by providing MET information as a SWIM-based information and by contributing to the Operational Solutions validation exercises. The solution will be completed in 2020, aiming to achieve TRL6 maturity level.

- Solution PJ.18-04c (MET and AIM information services in the aircraft information domain) defines and delivers a validated Technological Solution supporting the acquisition, processing and distribution of AIM and MET information and the representation of this information to airspace users. The solution will be completed in 2020, aiming to achieve TRL4 maturity level for a sub-set of AIM and MET information.

- Solution PJ.18-06a (Air Traffic Control (ATC) Planned Trajectory Performance Improvement) targets improvement of current Planned Trajectory Prediction algorithms, in ground ATC systems, using the currently existing/validated information coming from the aircraft (mainly

surveillance DAPs and new ADS-C reports). The solution will be completed in 2020, aiming to achieve TRL6 maturity level.

- Solution PJ.18-06b (Tactical and Network Manager (NM) Trajectory performance improvement) investigates the performance benefits that could arise from the use of Extended Projected Profile data provided by ADS-C). The solution will be completed in 2020, aiming to achieve TRL4 maturity level.

2.3.1.2   SESAR Solutions delivery: the Release process in 2019

The Release process is the process by which the maturity of candidate Solutions is assessed. In 2019, the Release 8 was completed and the majority of the Release 9 was carried out, with last activities of Release 9 taking place in 2020. The outcomes of these two releases are presented in the subsections below.

During the year 2019, SESAR JU and its Members got support from the SDSS (SESAR Development Support Services) in the implementation and execution of the processes and procedures required guaranteeing consistency in the Programme lifecycle. The SDSS contributed to the definition of the Release 9 Plan in identifying the different Solutions to be validated and delivered according to the Release process. Activities related to the maturity assessment of the Solutions have also been supported by SDSS through the delivery and maintenance of the maturity assessment tool together with the organisation of the maturity gates and the preparation of the required material as input and as outcomes of the gates. A few additional features have been implemented in the SDSS collaborative platform (STELLAR) used by the SESAR JU and by all projects in particular allowing to integrate the different project schedule into a programme schedule (ensuring consistent development between the projects with dependencies) and to provide different cockpit views on planning, deliverables assessment, maturity gates and releases delivery.

2.3.1.2.1   Release 8 outcome

The Release 8 was launched into execution early 2018 and concluded by April 2019. Its final scope covered the development and validation of 19 SESAR candidate Solutions, of which 9 in V2/TRL4 maturity level and 10 up to V1/TRL2 maturity level, allowing the projects to further develop the Solutions up to the V3/TRL6 maturity level in the context of future releases. The following candidate solutions were developed in the context of Release 8:

Solution ID	Solution name and description	Maturity level
	High-performing airport operations	
PJ.02-08	**Traffic optimisation on single and multiple runway airports:** Traffic optimisation on single and multiple runway airports provides tower and approach controllers with system support to optimise runway operations arrival and/or departure spacing and make the best use of minimum separations, runway occupancy, runway capacity and airport capacity. The scope of V2 phase covered only two features/concepts: • Concept 1: Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence. This concept applies namely to execution phase and addresses mainly TWR and TMA ATCOs;	V2

Solution ID	Solution name and description	Maturity level
	• Concept 2: Optimised use of RWY capacity for multiple runway airports with the combined use of an Integrated Runway Sequence and Runway Manager (RMAN). This concept applies namely to planning phase, uses forecasted data of traffic demand, capacity constraints and target KPIs and addresses TWR Supervisor although considers inputs from execution phase. **Expected performance benefits:** The solution has measured potential performance benefits on capacity, predictability and fuel efficiency.	
PJ.03a-09	**Surface operations by RPAS** Surface operations by Remotely Piloted Aircraft Systems (RPAS) facilitate the operation of RPAS at airports and their integration into an environment which is dominated by manned aviation. To the maximum extent possible, RPAS will have to comply with the existing rules and regulations. The solution includes the particular requirements of remotely piloted operations, and will describe their specificities with respect to the manned operations, providing operational requirements for technological developments that could mitigate them. Validation activities have been focused on defining the ATCo's and RPAS pilot's working methods including non-nominal situations e.g. loss of communication link and the evaluation of different alternatives to perform RPAS taxiing operations e.g. segmented standard taxi routes, segregated operations, towing operations. **Expected performance benefits:** The solution increases access and equity for IFR RPAS at the airport while maintaining a high level of safety and without a negative impact on human performance.	V1
PJ.04-01	**Enhanced Collaborative Airport Performance Planning and Monitoring** Enhanced Collaborative Airport Performance Planning and Monitoring extends the airport performance monitoring process to the airport landside and ground access processes that may have an impact on the airside operations in both planning and execution timeframes. It sees the development of rationalised dashboard(s) fed with all landside and airside key performance indicators and covering total airport management processes. The validation activities focused on assessing the impact of the landside processes into the final TOBT, the feasibility of having a new CDM concept for regional airports, post-operations analysis and cybersecurity aspects. **Expected performance benefits:** PJ.04-01 confirmed that early alerting capability, and sharing of information: • Increases predictability and accuracy, as they helped identify deviations and disruptions at an earlier stage, which lead to earlier implementation of mitigation actions (allocation of resources within the airport, etc.); • Increases flexibility, as they supported earlier and better decision making;	V2

Solution ID	Solution name and description	Maturity level
	• Increases punctuality, as consequence of increased predictability and flexibility.	
PJ.05-02	**Multiple Remote Tower Module** Remotely Provided Air Traffic Service for Multiple Aerodromes includes the provision of Aerodrome Control Service or Aerodrome Flight Information Service for more than one aerodrome by a single ATCO/AFISO from a remote location, i.e. not from a control tower local to any of the aerodromes. The ATCO (or AFISO) in this facility performs the remote ATS for the concerned aerodromes. It includes further development of the CWP and MET information from multiple airports. This solution goes beyond the scope of solution #52 (two small aerodromes). **Expected performance benefits:** The following benefits have been identified: • A reduction of ATCOs of up to 25% compared to Single Remote Tower; • Kept traffic levels for the targeted aerodromes; • Mix of IFR and VFR traffic is possible; • Different types of aerodromes can be paired in Multiple mode.	V2

✈ Advanced air traffic services

Solution ID	Solution name and description	Maturity level
PJ.010-01b	**Flight-Centric ATC:** Flight-Centric ATC sees the provision of ground-based automated support for managing separation provision across several sectors in order to enable larger sectors to be used. Rather than managing the entire traffic within a given sector. With this solution ATC is responsible for a certain number of aircraft throughout their flight segment within a larger airspace or along flows of traffic. validation activities focused on the definition of roles , responsibilities and tasks within the Flight Centric Area (FCA), the allocation strategies of flights/flows to ATCos, the management of conflicts within and outside the FCA and the identification of potential technical means for wide area communications. **Expected performance benefits:** With the new set-up of roles and tasks, as described above for mixed operational environments, productivity can potentially be increased as the number of controllers required to handle the traffic could be reduced.	V1
PJ.10-02a	**Improved Performance in the Provision of Separation**: Improved Performance in the Provision of Separation aims to improve the separation (tactical layer) in the en-route and TMA operational environments through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system, airborne information and data derived from meteorological services.	V2

Solution ID	Solution name and description	Maturity level
	The maturity gate focused exclusively on the solution elements that do not take into account EPP information, MET information or eFPL. It has been confirmed for both TMA and En-route environments: the solution can be integrated into the targeted operational system (existing working methods, procedures, human-machine interface, airspace organisation/sectors and traffic load). However, it is required to adjust some tools parameters' settings in order to gain more benefits in terms of performance and support for the controllers. **Expected performance benefits:** This solution aims at improving airspace capacity for TMA and En-Route through a reduction of ATCo workload.	
PJ.10-05	**IFR RPAS Integration** IFR RPAS Integration provides the technical capability or procedural means to allow RPAS to comply with ATC instructions. This first campaign of simulations attained valuable results in terms of requirements that should be considered to facilitate the integration of the RPAS into IFR operations. These requirements cover aspects such as flight plan information, ATCO HMI, contingency procedures, performance, latency, etc. **Expected performance benefits:** The solution increases access and equity for IFR RPAS in En-Route and TMA while maintaining a high level of safety and without a negative impact on human performance.	V1
PJ.11-A2	**Airborne Collision Avoidance for Remotely Piloted Aircraft Systems - ACAS Xu** Airborne Collision Avoidance for Remotely Piloted Aircraft Systems - ACAS Xu provides airborne collision avoidance to RPAS, building on optimised resolution advisories and additional surveillance data, while taking into account the operational specificities of RPAS (the additional surveillance sources could be ADS-B but also any other sensor installed on the RPAS). Results indicate that the solution uses extensively horizontal manoeuvring. In general, obtained results indicate considerable impact of the type of surveillance on ACAS Xu performance. In particular for non-cooperative radar sensor, there were some surprising results in terms of miss distance. The preliminary analysis of ACAS Xu alerting in today's operational mixed-equipped scenarios shows that ACAS Xu will typically alert more often and earlier than manned aviation systems (TCAS II or ACAS Xa). **Expected performance benefits:** Results of the V1 fast time simulations showed that under nominal conditions (and assuming timely reaction to alert), the solution correctly prevented Near Mid-Air Collision in all simulated collision scenarios.	V1

Founding Members

Solution ID	Solution name and description	Maturity level
PJ.11-A4	**Airborne Collision Avoidance for General Aviation and Rotorcraft - ACAS Xp** Airborne Collision Avoidance for General Aviation and Rotorcraft - ACAS Xp provides Airborne Collision Avoidance to GA/RC, taking into account their limited capability to carry equipment and their operational specificities. First phase of TSAA+ evaluations included three independent Fast-Time Simulation exercises, which have been using three different simulation platforms but the same input – a sample of real European de-identified mixed-equipage encounters (TCAS equipped/TCAS-unequipped). Encounter set consisted of more than 3500 scenarios, in both En-Route and TMA environment. **Expected performance benefits:** • TSAA with "+" feature can introduce interesting operational benefits in European airspace, which will be further evaluated next validation phase with pilot involvement • Even TSAA without "+" capability can introduce promising safety benefits in terms of NMAC probability in European airspace; • The performance of TSAA without "+" functionality, meets the required thresholds in most of the cases, however, improved data set with better distinction of the encounters is needed for more significant results.	V1

Optimised ATM network services

| PJ.07-03 | **Mission Trajectory Driven Processes:**

The solution refers, through a full integration of the WOC within the ATM system, to the updating of wing operations centre (WOC) processes for the management of the shared and reference mission trajectory (SMT/RMT). These processes respond to the need to accommodate individual military airspace user needs and priorities without compromising optimum ATM system outcome and the performances of all stakeholders.

This SESAR Solution has been validated through a series of activities including a Real-time Simulation of the main human tasks in the 3 operational nodes ATC, NM and WOC. A Human Performance analysis was conducted for the updated parts of the prototypes as part of the activities. Based on the results of these activities validation exercise the life cycle of the iOAT Flight Plan has been successfully validated at V2 level from the planning phase until the end of the execution of the mission.

Expected performance benefits:

The SESAR solution aims at improving civil military coordination with due respect to military ATM requirements using automated systems; at increasing flexibility to facilitate short notice military requests and at Safeguarding military confidentiality requirements through security gates. | V2 |

Solution ID	Solution name and description	Maturity level
	Enabling aviation infrastructure	
PJ.14-02-04	**FCI Network Technologies incl. voice solutions and military interfacing:** The solution sees the migration towards Internet protocol, enabling network-centric SWIM architectures, interfacing with military. The solution describes the multilink concept to support the flexible usage of all the available connections in critical conditions, develops further the mobility concepts considering the latest developments in the industry and specifies an advanced network management to operate and integrate the multiple data link technologies. It also includes first considerations of the technical security aspects Initial Transversal and Complementary Studies have been performed to cover transversal aspects including performance, safety and security. The FCI architecture, functional and interfaces requirements for wave 1 have been defined. **Expected performance benefits:** The SESAR solution aims at improving capacity, efficiency, safety and resilience of the current CNS infrastructure together with a positive economic impact on the deployment of the overall future communications system.	TRL-2
PJ.14-02-05	**Development of new services similar to FIS-B to support ADS-B solutions for General Aviation:** The solutions aims at developing new services similar to Flight Information System-Broadcast (FIS-B) to support Automatic Dependent Surveillance - Broadcast (ADS-B) solutions for General Aviation such as broadcast (ADS-B) solutions for GA. The information will be displayed on mobile devices (e.g. tablets) in order to avoid expensive retro-fitting actions on GA aircraft. The provision of this additional information will not change pilots¿ duties or flight rules, but will provide pilots with real-time traffic data as well as updated NOTAM, weather and FUA data. **Expected performance benefits:** The SESAR solution aims at improving safety through the provision of real-time traffic information and updated weather data during flight that will allow safe GA pilots' decisions in due time (e.g. diversions to alternate routes or airports) and avoidance of unauthorised airspace penetration due to better planning information available in real time, allowing for early decisions regarding the flight execution.	V1
PJ.15-01	**Sub-regional Demand Capacity Balancing Service:** The solution aims at facilitating an improved usage of the airspace at sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed. The activities in this phase have proven the technical feasibility of this common service.	TRL-4

Founding Members

Solution ID	Solution name and description	Maturity level
	Expected performance benefits:	
	The solution aims at improving usage of the airspace at sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed. The solution improves cost-efficiency.	
PJ.15-02	**Delay Sharing Service:**	
	The solution operates the AMAN functionalities within an extended horizon to provide local and overall arrival sequences for planning and tactical operational purposes in a cross border environment.	
	Assuming that providers are capable of a provision of E-AMAN, based on a SWIM foundation, deploying this common service results in:	
	• The requirement to deploy fewer engineered capabilities;	
	• Service improvement roadmap across Europe is consistent and the associated costs are spread across common service ANSP consumers.	
	The technical validation exercises have demonstrated the technical feasibility of two different scenarios of the E-AMAN Common Service: the co-located and the federated scenario. Those scenarios have been validated in separate validation exercise with different partners and prototypes. The validation of the co-located scenario has been conducted with live data whereas the federated scenario has been validated using recorded live data.	TRL-4
	Expected performance benefits:	
	The solution aims at improving cost-efficiency thanks to reduction of the cost of deployment because a lower number of system needs to be implemented and the reduction of the yearly operating costs because a lower number of technical systems needs to be securely maintained in operation.	
PJ.16-03	**Work Station, Service Interface Definition & Virtual Centre Concept:**	
	The solution will provide an operating environment in which different ATS units, even across different ANSPs, will appear as a single unit and will be subject to operational and technical interoperability. It includes the development of the ATSU architecture from a service oriented approach with a focus on the technical services and common interfaces. Based on the Virtual Centre concept, the CWP/HMI needs to interface with multiple ATM Data Service Providers (ADSPs). A high performing and reliable underlying communication infrastructure may be needed. This solution encompasses en-route and TMA and airport/TWR environments.	TRL-2 and TRL-4
	it has been proven that:	
	• ATSU can subscribe to services in particular those offered by an ADSP where ATSU and ADSP have different suppliers;	
	• CWP(s) developed by a vendor can subscribe to services offered by different vendors;	
	• CWP(s) developed by different vendors can subscribe to services offered by one ADSP;	

Solution ID	Solution name and description	Maturity level
	• ATSU(s) can connect remotely to ADSP(s) through a WAN; • An initial estimation of Quality of Service indicators for the Virtual Centre concept has been obtained from exercise data. **Expected performance benefits:** The solution aims at enabling Europe to move to an interoperable, cost-efficient and flexible service provision infrastructure. Decoupling of the CWPs should enable a more efficient use of the most valuable and expensive resource, the human. By enabling increased flexibility the ANSPs should better manage staffing for prevailing traffic conditions and assure service continuity.	
PJ.16-04	**Workstation, Controller productivity:** The solutions includes the development of new human machine interface (HMI) interaction modes: Multi-Touch Inputs (MTI), Automatic Speech Recognition (ASR), Attention Guidance (AG), User Profile Management Systems (UPMS), and Qualification of CWP Virtualisation (CWPV). Activities in Release 8 were focused on the development of operational concept and use cases for the new interaction modes as well as the development of functional requirements. **Expected performance benefits:** The solution aims at improving the ATCO productivity thanks to the new HMI interactions that would increase automation and reduce ATCO actions.	TRL-2
PJ.17-01	**SWIM TI Purple Profile for Air/Ground Advisory Information Sharing:** The solution supports ATM operational improvements that depend on A/G information exchanges to enable better situational awareness and collaborative decision-making. This includes the specification of technical architecture and functions that are required to achieve full interoperability between air and ground SWIM segments and meet the safety and performance requirements required by airborne operations. Main purpose in Release 8 was to evaluate technical feasibility of the core aspects concerning technical architecture, messaging capabilities, information exchange level security controls and interface requirements **Expected performance benefits:** PJ.17-01 solution supports ATM operational improvements that depend on Air/Ground (A/G) information exchanges to enable a better situational awareness and collaborative decision making, with a focus on advisory information. The solution aims at contributing positively to global interoperability by designing and validating in collaboration with EU members innovative and open standards based solution for the integration of the Aircraft into the SWIM "network", ensuring that safety and security requirements are met.	TRL-4
PJ.17-03	**SWIM TI Green profile for G/G Civil Military Information Sharing:** The solution ensures that protocols and data models used in military systems can be interfaced with SWIM with adequate quality of service levels	TRL-2

Founding Members

EUROPEAN UNION   EUROCONTROL

Solution ID	Solution name and description	Maturity level
	maintained. It will complement the Air/Ground SWIM Purple Profile for advisory services. Release 8 activities focused on capturing SWIM-based civil-military exchange needs from a military point of view, define the functional requirements in line with military expectations and make the technological solution cost-efficient. **Expected performance benefits:** The solution aims at improving civil-military coordination and cooperation supporting a wide range of SWIM services covering military expectations.	
PJ.17-08	**SWIM TI Common runtime registry:** The solution facilitates the definition of the interfaces for publication, look-up, management and network of registries as well as the definition of non-functional requirements. Due to budget limitations on the programme the solution was de-scoped at the beginning of TRL4 and it was decided to perform only a partial TRL4 maturity stage. The SESAR JU recommended to stop the development of the solution given that, at this stage, no immediate operational need for online selection of services and dynamic binding was identified **Expected performance benefits:** The SESAR solution aims at improving safety/resilience by allowing the user to switch to an alternative service in case the primary service fails.	TRL-4 not completed

Table 2: Outcome of the Release 8

In relation with the outcome of Release 8, 3 VLD projects successfully performed initial iterations of their demonstrations activities, providing initial results that will be further consolidated with Release 8 and Release 9 results:

The VLD project **PJ.24 NCM** 'Network Collaborative Management' based on a collaborative approach in Air Traffic Flow and Capacity Management (ATFCM), involving the whole spectrum of ATM actors: Airspace Users (AUs), Airports, Air Navigation Service Providers (ANSPs) and Network Manager (NM). Nine exercises over a large part of Europe with the collaboration of major European airlines, have demonstrated, for several weeks in the timeframe 2017-2019, network performance benefits and opportunities of improved cooperation techniques supported by connected local and network tools.

Exercises included demonstrations of:

- targeted flow and flight measures such as level-capping re-routings, flow and flights ground delays, slot improvements, slot exclusions,
- target Time of Arrival measures to reduce arrival delay and optimize arrival sequences,
- early exchange of departure planning information for predictability improvements,
- sub-regional FMP coordination improvements including meteo coordination.

The cooperative approach between all stakeholders to reduce existing network inefficiencies was seen as the major success factor of demonstration exercises, leading to network performance benefits. NCM operational demonstrations successfully resulted in significant delay savings, significant positive impact on cost-efficiency due to better (system-supported) workflow processes, positive impact on

predictability, with no impact on safety. Airspace Users concluded that NCM demonstrations benefits outweighed possible negative impact on airlines' operational costs due to non-optimal flight routings.

The VLD project **PJ.25 XSTREAM** 'Cross Border SESAR Trials for Enhanced Arrival Management' aims at validating and assessing new arrival management tools in order to reduce the use of operational measures to absorb delays at low levels in TMA and improve flight efficiency.

Trials have been performed from July 2017 to Oct 2019 on major European hubs (London-Gatwick, London-Heathrow, Paris-Orly, Paris-CDG, Zurich and Frankfurt), as well as involving a large number of surrounding area control centers (UAC/ACCs) and Airspace Users.

Conclusions show very promising benefits in terms of environment (fuel gains), capacity (ATFCM delay and complexity reduced in TMA) and flexibility (reduction of cost of delay for Airspace Users), which are further detailed in this report.

- DEMO Exercise 07-003 "Improved arrival planning management and airspace users' preferences" aimed at demonstrating how TTA and AUs preferences can combine with extended arrival management, for increased cost efficiency and flexibility. The exercise results showed the feasibility to:
  - o provide pre-departures TTA in different use cases (e.g. full or part of the arrival flows) and share this TTA with all concerned actors (NM, AUs, upstream ACCs). Those TTA are generated locally to make a better use of available capacity;
  - o exchange flights in arrival sequence (grounded or airborne) according to the AUs business needs;
  - o reroute long-hauls (dDCB at extended AMAN Horizon) in collaboration with the AUs
  - o Results have shown no change on the regulation rates and a delay reduction around 4-9%. The FMP feedback has been very positive and 100% agree that the demonstrated concepts bring benefits in particular at operational level and as a way to mitigate sector complexity.

- DEMO Exercise 08-003 "Arrival Planning Management & NM integration" aims at improving the iStream tool with additional functionalities:
  - o a B2B download link to retrieve Archive flight data from NM and establish a post-analysis presentation for statistics and analysis purposes;
  - o a B2B uplink channel to send ETOs (received from long-hauls outside IFPS zone) (to be confirmed upon feasibility assessment) and TTOs from the computed sequence.

PJ.28 "Integrated Airport Operations" aims at demonstrating a series of airport related solutions validated in SESAR 1. The following demonstration activities were planned in Release 9 timeframe:

- EXE-01: The demonstration at Nice airport will present a system that provides planned taxi routes for aircraft and enables controllers to update it with all clearances given over radio to aircraft. The departure manager (DMAN) will also take into consideration additional data, provided by the advanced Surface Movement planned taxi routes. Furthermore, the Nice demonstration will address the detection of Conflicting ATC Clearances (CATC) and Conformance Monitoring Alerts for Controllers (CMAC);

- EXE-02: The aim of the On-board Traffic Alerts demonstration work package is to provide evidence, that the performance of real ADS-B data is sufficient to support the function of on-board alerting technology. These use ADS-B technology to get information about surrounding traffic so the ADS-B data performance is a key enabler for its proper functions. The On-board Traffic Alerts demonstration will contribute to the SESAR project On-board Traffic Alerts (SESAR project PJ.03b-05;

- EXE-03: In the demonstration at Budapest airport the ATC system will provide surface routes to the controller together with the ability to modify them and provide the necessary clearances based on the route information. This functionality is also an enabler for alerts detecting conflicting ATC clearances given and entered into the system by the Ground or Aerodrome/Runway controller (CATC alerts), as well as for alerts indicating non-conformance to instructions or clearances (CMAC alerts). These alerts are provided to the controller to ensure safe operations. Furthermore, in the Budapest demonstration the ATC system synchronizes a pre-departure sequence of TSAT based on accurate planned taxi times and runway sequence, which improves the predictability of all airport operations and so optimizes the capacity of the Airport;

- EXE-04: the exercise will take place at Hamburg Helmut Schmidt Airport. We shall use the Airport Research and Innovation Facility (ARIF) from DLR (AT-One) at EDDH for the demonstration exercises that will be conducted in passive shadow mode, not interfering with live operations, however, the demonstration will use live data as input ARIF will be integrated with the SINTEF ATC Optimization Service validated in SESAR 1. ARIF's A-SMGCS Traffic Situation Display will be extended with ATCO interaction capabilities to communicate with the SINTEF ATC Optimization Service.

The VLD project **PJ.31 DIGITS** 'Initial Trajectory Information Sharing', performed the following demonstration activities:

- Further simulator sessions were carried out between the Airbus workbench, Eurocontrol-EEC datalink testbed and several ANSPs ground platforms addressing different points, such as logon to the CM server, ATN B2 tests supporting ADS-C and CPDLC, etc. Overall, the tests verified that the technical infrastructure is ready to support the large-scale demonstrations with development and revenue flights at a later stage;

- Exercises with development flights were fully rolled-out, including live trial with a dedicated Airbus A320 development flight that was performed in February 2019;

- the FANS-C certification was successfully completed for the update of the FMS from one of the PJ.31 industrial partners, while a second certification for a different partner is planned in early 2019. In parallel, ground platforms for the PJ.31 ANSPs have been updated as well to be able to support the ADS-C downlink and the display of route discrepancy monitoring.

- Finally, an important milestone was achieved in March 2019 when the first FANS-C equipped aircraft was delivered to one of the airline partners in the project.

2.3.1.2.2 Release 9 execution

The Programme Committee approved the Release 9 Plan at its ninth session held in December 2018 meeting, launching the Release 9 into execution until March 2020. The Release 9 Plan covered:

- 6 SESAR Solutions that expect to achieve V1/TRL2 in the course of Release 9 timeframe through different validation exercises and activities;

- 38 SESAR Solutions that are expected to complete V2/TRL4,

- 23 SESAR Solutions that are expected to complete V3/TRL6.

Since the approval of the Release Plan, a number of changes have occurred during the execution of Release 9 activities:

- In preparation for the maturity gates in Release 9, a number of solutions have been split in order to better reflect elements that are ready for industrialization ("deployable solutions"), and distinguish them from those that would require additional research and development beyond Wave 1.

- Some solutions that did not initially plan to complete a maturity level in Release 9 (on-going Vx/TRLy) have progressed further than expected and they are reported in the table below).

- On the other hand, some solutions that had planned a maturity gate in Release 9 did not finally perform it because key elements of the data pack were not available.

- The Release 9 Plan included maturity gates planned beyond April 2020 e.g. PJ.18-02b, PJ.18-02b, PJ.18-06a and PJ.18-06b. After agreement at DMSC, the solutions performing maturity gates beyond that date will be part of Release 10 rather than Release 9.

The following tables provide information on the solutions delivered in the context of Release 9:

Solution ID	Solution name and description	Target maturity level
	High-performing airport operations	
PJ.02-01	**Wake turbulence separation optimization:** PJ.02-01 Solution aims to optimize wake turbulence separation minima for arrivals and departures to enhance airport runway throughput. It focuses on development of: • wake separations reductions based on weather and static aircraft characteristics; • a separation delivery support tool for ATCOs; • a wake risk monitoring function (ground and airborne); • a wake vortex decay enhancing device. **Expected performance benefits:** The solution aims at improving increase arrival and departure runway capacity, efficiency, predictability and resilience while maintaining or increasing safety.	V3 (maturity gate planned in 2020)

Solution ID	Solution name and description	Target maturity level
PJ.02-02	**Enhanced Arrival Procedures** Enhanced arrival procedures make use of satellite navigation and augmentation capabilities, such as GBAS and satellite-based augmentation systems (SBAS), to enhance landing performance and to facilitate advanced arrival procedures (e.g., glide slope increase, displaced runway threshold). By doing so, noise is reduced while runway occupancy time (ROT) is optimised. The solution also reduces the need for separation for wake-vortex avoidance. **Expected performance benefits:** The solution will enable mitigation of noise (Environmental Sustainability) and allow for reduced wake separation and consequently runway throughput increase (Capacity and Efficiency).	V3 (maturity gate planned in 2020)
PJ.02-03	**Minimum-Pair separations based on RSP:** Minimum Pair Separations based on Required Surveillance Performance (RSP) aims the application (by ATC) of non-wake turbulence pair wise separation (PWS) of 2NM for arrivals on final approach (at the point that the leading aircraft in the pair crosses the runway threshold), based upon Required Surveillance Performance (RSP). **Expected performance benefits:** The solution will enable the reduction of minimum radar separation (MRS) from 2.5 NM down to 2.0 NM on final approach increasing runway throughput (Capacity, Efficiency and Resilience).	V3 (maturity gate planned in 2020)
PJ.02-05	**Independent Rotorcraft operations at the Airport:** Independent Rotorcraft (RC) operations at the airport refer to RC specific approach procedures and SBAS-based point-in-space (PinS), which aim to improve access to secondary airports in Low Visibility Conditions (LVC). **Expected performance benefits:** The solution will enable rotorcraft operations in airports where today are not allowed increasing access and equity, safety and fuel efficiency.	V3
PJ.02-06	**Improved access into secondary airports in low visibility conditions:** Improved access into secondary airports in low visibility conditions will be possible thanks to the introduction of new airborne capabilities, such as RNP and global navigation satellite system (GNSS)-based landing systems. **Expected performance benefits:** The solution aims at improving access to secondary airports are currently suffering from limited infrastructure both from the air and ground perspective in particular when visibility conditions are degraded.	V2 (maturity gate planned in 2020)

Solution ID	Solution name and description	Target maturity level
PJ.02-08-01	**Trajectory based Integrated Runway Sequence** The main goal for the Integrated RWY Sequence function is to establish an integrated arrival and departure sequence by providing accurate Target Take off Times (TTOTs) and Target Landing Times (TLDTs), including dynamic balancing of arrivals and departures while optimising the runway throughput. The look ahead Time Horizon e.g. 1 hour is the time at which flights become eligible for the integrated sequence. The Stable Sequence Time Horizon is the time horizon within which no automatic swapping of flights in the sequence will occur, but landing and departure time will still be updated. The value of these time horizons is determined by the local implementation and they are not necessarily the same for arrivals and departures. **Expected performance benefits:** The solution aims at increasing airport capacity, punctuality and predictability.	V3
PJ.02-08-02	**Runway Manager** The runway Manager (RMAN), a support tool for the Tower Supervisor to determine the optimal runway configuration and distribution of demand according to capacity and local constraints. During the Medium/Short term Planning Phase, the RMAN tool checks the intentional demand versus the available capacity and it is capable of forecasting imbalances, raising alarms and alerts based on the indicators provided. In the Execution Phase, the Runway Management tool monitors departure, arrival and overall delay and punctuality, in addition to the capacity shortage proposing changes if necessary. **Expected performance benefits:** The solution aims at increasing airport capacity.	V3 (maturity to be confirmed in 2020)
PJ.02-08-03	**Increased Runway Throughput based on local ROT characterization (ROCAT)** The Increased Runway Throughput based on local ROT characterization ROCAT is a concept that intends to reduce the in-trail separation on final approach with the aim of increasing runway throughput by taking into account the Runway Occupancy Time (ROT). The most constraining factor for the reduction of the separation is, together with the wake turbulence, the ROT; and therefore a new separation minimum could be computed based on the prediction of the ROT, the MRS and the wake categorization separation. ROCAT defines separation sub-categories based on runway occupancy time, wake minima from RECAT and reduced radar separation based on ICAO approved minima. **Expected performance benefits:** The solution aims at increasing airport capacity.	V3 (maturity to be confirmed in 2020)

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Solution ID	Solution name and description	Target maturity level
PJ.02-08-04	**Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT):** Enhanced AROT Predictor is relying on a dynamic estimation of Arrival Runway Occupancy Time (AROT) and runway exit to deliver corresponding optimised advisory to Tower Runway Controller. The advisory service is delivered directly into Controller Working Position (CWP) in form of additional dynamic Electronic Flight Strip (EFS) entries. The information about the estimated runway exit and AROT is available up to 5 min before landing for each arriving flight. The optimised ROT/runway exit information may be used by Tower Runway Controller to give recommendations to arriving Flight Crews and maintain awareness of expected aircraft landing performance. This is expected to positively benefit Runway Capacity by reducing AROT in peak conditions. **Expected performance benefits:** The solution aims at increasing airport capacity, punctuality and predictability.	V2
PJ.02-11	**Enhanced Terminal Area for efficient curved operation:** Enhanced Terminal Area for efficient curved operations refers to curved segment for departures and approaches as close to the runway as possible to optimise procedures in terms of fuel consumption, noise abatement and environmental constraints. Using geometric vertical navigation guidance in the TMA approach phase will remove the workload associated to barometric to geometric vertical navigation transition. **Expected performance benefits:** The solution will provide the possibility to shorten path for all aircraft to the airport (thanks to curved operations) improving continuous descending operations (both leading to environmental sustainability and fuel efficiency benefit) while reducing flight crew and ATCO workload and situation awareness (Safety and Human Performance benefit).	V1
PJ.03a-01	**Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing:** Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing sees the extension of the A-SMGCS routing function to avoid potential traffic conflicts, an improved use of AMAN and DMAN information and integration with total airport management procedures. It includes the exchange of virtual stop bar identifier and status between ATCOs and flight crews to improve safety in low visibility conditions. The exchange of information between ATC and vehicles/aircrafts will be improved with the use of airport data link and other guidance means. **Expected performance benefits:** The solution aims at improving efficiency and predictability.	V2
PJ.03a-03	**Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface** Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface refers to improved accuracy of aircraft navigation during both	TRL-4

Solution ID	Solution name and description	Target maturity level
	take-off and landing operations, as well as improved accuracy for surface movement navigation and service vehicle positioning (using GBAS or SBAS corrections). **Expected performance benefits:** The solution aims at providing accurate navigation information to support the integration of surface management processes and for the safety of aircraft movements during taxi, in particular in poor weather conditions.	
PJ.03a-04	**Enhanced Visual Operations:** Enhanced Visual Operations refers to enhanced vision systems (EVS) and synthetic vision systems (SVS), which will be developed to enable more efficient taxi, take-off and landing operations in LVC. This is applicable to all platforms: even if main airline platforms have autoland capabilities to facilitate approaches in LVC, they have no capability to facilitate taxi and take-off in order to maintain airport capacity. **Expected performance benefits:** The solution aims at providing further operational efficiency covering landing, taxi and take off during low visibility conditions	V3
PJ.03a-09	**Surface operations by RPAS** Surface operations by Remotely Piloted Aircraft Systems (RPAS) facilitate the operation of RPAS at airports and their integration into an environment which is dominated by manned aviation. To the maximum extent possible, RPAS will have to comply with the existing rules and regulations. The solution includes the particular requirements of remotely piloted operations, and will describe their specificities with respect to the manned operations, providing operational requirements for technological developments that could mitigate them. **Expected performance benefits:** The solution increases access and equity for IFR RPAS at the airport while maintaining a high level of safety and without a negative impact on human performance.	V2
PJ.03b-01	**Enhanced Airport Safety Nets for Controllers** Enhanced Airport Safety Nets for Controllers: Safety alerts for controllers detect potential and actual conflicting situations, incursions and non-conformance to procedures or ATC clearances, involving mobiles (and stationary traffic) on runways, taxiways and in the apron/stand/gate area as well as unauthorised/unidentified traffic. Controllers are provided in all cases with the appropriate alerts. **Expected performance benefits:** The solution increases airport safety.	V2
PJ.03b-03	**Conformance Monitoring Safety Net for Pilots** Conformance monitoring safety net for Pilots provides to the Flight Crew the Conformance monitoring safety alerts generated by the on-board system when the system detects a non-compliance with airport configuration (e.g.	V2

Solution ID	Solution name and description	Target maturity level
	closed runway, non-compliant taxiway, restricted area) as well as non-conformance to procedure or clearances. **Expected performance benefits:** The solution increases airport safety.	
PJ.03b-05	**Traffic Alerts for Pilots for Airport Operations** Traffic Alerts for pilots for airports operations refer to enhancing on-board systems in order to detect risks of collision with other traffic during runway and taxiway operations. In all cases the flight crew are provided with appropriate alerts. **Expected performance benefits:** The solution increases airport safety.	V3
PJ.03b-06	**Safety support tools for avoiding runway excursions** Safety support tools for avoiding runway excursions. **Expected performance benefits:** The solution increases airport safety.	V2
PJ.04-02	**Enhanced Collaborative Airport Performance Management:** The solution builds on work performed in SESAR 1 and moves towards the collaborative management of airport performance, especially in degraded situations. Enhanced collaborative airport performance management will be facilitated by access to real-time information captured in the form of performance dashboards showing 'what has happened', 'what is happening' but importantly 'what is predicted to happen' – including the identification of trends and potential performance deviations. The importance of demand and capacity balancing across the different airport processes and infrastructure elements will be captured within the Solution where work performed in SESAR 1 focussing solely on the runway will be extended. **Expected performance benefits:** The solution aims at delivering high precision performance dashboards providing problem identification (and prediction) capabilities). The information being used by the airport in the decision-making processes will cover all key infrastructure elements and processes, improving predictability, capacity and fuel-efficiency.	V2
PJ.05-02	**Remotely Provided Air Traffic Service for Multiple Aerodromes:** The solution includes the provision of Aerodrome Control Service or Aerodrome Flight Information Service for more than one aerodrome by a single ATCO/AFISO from a remote location, i.e. not from a control tower local to any of the aerodromes. The ATCO (or AFISO) in this facility performs the remote ATS for the concerned aerodromes. It includes further development of the CWP and MET information from multiple airports. **Expected performance benefits:** The solution aims at increasing efficiency per ATCO by introducing Multiple Remote Tower for aerodromes with larger amounts of traffic than those	V3 (maturity to be confirmed in 2020)

Solution ID	Solution name and description	Target maturity level
	validated in SESAR 1 (more aerodromes could be paired with others during longer periods per day) while keeping safety.	
PJ.05-03	**Remote Tower Centre with a flexible allocation of aerodromes to multiple Remote Tower Modules:** Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules will enable the provision of remote tower services to a large number of airports with a flexible and dynamic allocation of airports connected to different RTM over time. It includes the development of RTC supervisor and support systems and advanced automation functions for a more cost efficient solution, integration of approach for airports connected to the remote centre and connections between RTCs with systems for flow management between remotely connected airports and development of tools and features for a flexible planning of all aerodromes connected to remote tower services. **Expected performance benefits:** The solution aims at delivering performance benefits in terms of cost efficiency (higher ATCO productivity) and the solution potential to add further traffic to one ATCO (while avoiding overload situations) than in solution PJ.05-02.	V2
PJ.05-05	**Advanced Automated MET System:** Advanced Automated MET System will significantly enhance current possibilities of automated weather observation. This will be achieved by improving the monitoring of current weather situation while special attention will be given to inhomogeneous weather conditions with heightened aviation impact at remote aerodrome whereas data needed will be gathered from both standard and advanced observing tools. This technological solution will support and complement usage of Remote Tower, however it will be independent and can be advantageously used also with conventional Towers. **Expected performance benefits:** The solution aims at providing improved automated weather observation to airports in a cost efficiency manner. The solution improves the current weather situation e.g. in inhomogeneous weather conditions gathering MET data from both standard and advanced observing tools	TRL-4

✈ Advanced air traffic services

PJ.01-01	**Extended Arrival Management with overlapping AMAN operations and interaction with DCB and CTA:** Extended Arrival Management with overlapping AMAN operations and interaction with DCB integrates information from multiple arrival management systems, enabled by SWIM, operating out to extended ranges into en-route sectors using local traffic/sector information and balancing the needs of each AMAN. The solution addresses the interaction between Traffic Synchronisation and DCB, including the identification of integration needs, and CTA in high density/complexity TMAs.	V2

Solution ID	Solution name and description	Target maturity level
	Expected performance benefits: The solution aims at delivering performance benefits in terms of Safety, Fuel Efficiency, Cost Efficiency, Capacity in TMA and Predictability	
PJ.01-02	**Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA:** Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA sees TMA traffic managed in near real time, taking advantage of predicted demand information provided by arrival and departure management systems from one to multiple airports. This allows the identification and resolution of complex interacting traffic flows in the TMA and on the runway, through the use of AMAN and DMAN flow adjustments and ground holdings. **Expected performance benefits:** The solution aims at delivering performance benefits in terms of lower controller workload, improved situational awareness, reduced fuel consumption, increase of capacity in TMA and higher predictability	V2
PJ.01-03A	**Improved Parallel Operations:** The solution improves parallel approach operations through the application of PBN/RNP navigation specifications and the development of enhanced ATC procedures. The Solution will provide alternative options for independent parallel operations in medium to high density TMAs, using RNP to replace in particular vectoring to final intercept with closed loop routes and associated operating methods. **Expected performance benefits:** The solution aims at delivering the following performance benefits: • Safety by reducing the likelihood of blunders between aircraft performing simultaneous parallel approaches; • Capacity: once Safety targets are met or exceeded, a Capacity increase may be unlocked; • Environmental Sustainability by allowing more optimal vertical profiles and by increasing the predictability of the noise footprint.	V2
PJ.01-05	**Airborne Spacing Flight Deck Interval Management:** The solution refers to new ASAS spacing interval management sequencing and merging (ASPA IM S&M) manoeuvres encompassing the potential use of lateral manoeuvres and involving more complex geometries where a designated target aircraft may not be flying direct to the merge point. The solution combines more accurate delivery at the metering fix, typically the Initial Approach Fix, and ASPA-IM manoeuvres addressing speed and energy control while adhering to PBN routes in the TMA. **Expected performance benefits:** The expected performance benefits include noise benefits, improved runway throughput/TMA capacity, predictability and fuel efficiency.	V2

Solution ID	Solution name and description		Target maturity level
PJ.01-06	**Enhanced Rotorcraft and GA operations in the TMA** The solution further develops the simultaneous non-interfering (SNI) concept of operations to allow RC and GA to operate to and from airports without conflicting with fixed-wing traffic or requiring runway slots. **Expected performance benefits:** The solution is expected to provide improvements on access and equity for rotorcraft operations, safety and fuel efficiency		V3
PJ.01-07	**Approach Improvement through Assisted Visual Separation** The solution refers to cockpit display of traffic information (CDTI) assisted visual separation (CAVS) and CDTI assisted pilot procedure (CAPP) applications that enable aircraft to separate each other visually in marginal visual conditions and that facilitate transitions from IFR operations to CAVS**.** **Expected performance benefits:** The solution aims at improving fuel efficiency.		V2
PJ.06-01	**Optimized traffic management to enable Free Routing in high and very high complexity environments** The solution sees airspace users being able to plan flight trajectories without reference to a fixed route network or published directs within high and very high-complexity environments so they can optimise their associated flights in line with their individual operator business needs or military requirements. **Expected performance benefits:** Benefits are expected on Fuel efficiency and Predictability, while Capacity, Safety and human performances must not be negatively impacted.		V3
PJ.06-02	**Management of Performance-Based Free Routing in Lower Airspace** This solution addresses the application of FRA for airspace users beyond the PCP expectations (below FL310), improving predictability, efficiency and flexibility for a wider range of different airspace users. **Expected performance benefits:** Benefits are expected on flight efficiency, capacity and environmental sustainability without degradation in the safety levels.		V2
PJ.10-01a1	**High Productivity Controller Team Organisation in En-Route (including eTMA) (1PC – 2ECs)** High Productivity Controller Team Organisation sees the extension of sector team operations beyond team structures of one planning ATCO and two tactical ATCOs E-TMA in order to optimise flight profiles, minimise delays and improve ANSP cost efficiencies while taking into account intrinsic uncertainty in the trajectory. **Expected performance benefits:** The solution aims at delivering performance benefits in terms of cost efficiency (ATCO productivity) and reduction of delays.		V3

Founding Members

Solution ID	Solution name and description	Target maturity level
PJ.10-01a2	**High Productivity Controller Team Organisation in En-Route (1PC – 3ECs)** High Productivity Controller Team Organisation sees the extension of sector team operations beyond team structures of one planning ATCO and two tactical ATCOs in en-route in order to optimise flight profiles, minimise delays and improve ANSP cost efficiencies while taking into account intrinsic uncertainty in the trajectory. **Expected performance benefits:** The solution aims at delivering performance benefits in terms of cost efficiency (ATCO productivity) and reduction of delays.	V1
PJ.10-01b	**Flight-centric ATC:** The solution sees the provision of ground-based automated support for managing separation provision across several sectors in order to enable larger sectors to be used. Rather than managing the entire traffic within a given sector. With this solution ATC is responsible for a certain number of aircraft throughout their flight segment within a larger airspace or along flows of traffic. **Expected performance benefits:** The solution aims at improving en-route airspace capacity, cost efficiency (increase of ATCO productivity), fuel Efficiency and predictability.	V2
PJ.10-01c	**Collaborative Control** The solution refers to coordination by exception rather than coordination by procedure and is facilitated by advanced controller tools, supporting reduced need for coordination agreements, fewer boundary constraints and the ability to combine sectors into multi-sector planner teams. **Expected performance benefits:** The solution aims at delivering performance benefits in terms of cost efficiency (ATCO productivity), reduction of delays and improvements on fuel efficiency.	V2
PJ.10-02a1	**Integrated tactical and medium Conflict Detection & Resolution (CD&R) services and Conformance Monitoring tools for En-Route and TMA** This solution aims at improving the separation (tactical layer) in the En-Route and TMA operational environments through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and airborne information such as Mode-S data. **Expected performance benefits:** Performance benefits include improvements on cost efficiency (ATCO productivity), safety and predictability	V3

Solution ID	Solution name and description	Target maturity level
PJ.10-02a2	**Improved performance in the provision of separation with use of ADS-C/EPP data** The solution aims at improving the separation (tactical layer) in the En-Route operational environment through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and ADS-C/EPP airborne information **Expected performance benefits:** Performance benefits include improvements on cost efficiency (ATCO productivity), safety and predictability	V1
PJ.10-02b	**Advanced Separation Management** The solution aims to further improve the quality of services of separation management in the en-route and TMA operational environments by introducing automation mechanisms and integrating additional information (ATC intent, Aircraft intent). **Expected performance benefits:** Performance benefits include improvements on cost efficiency (ATCO productivity), safety and predictability	V1
PJ.10-05	**IFR RPAS Integration:** The solution provides the technical capability or procedural means to allow IFR RPAS to comply with ATC instructions. **Expected performance benefits:** The solution aims at improving access and equity to TMA and en-route environments since the solution will facilitate the safe integration of IFR RPAS in different types of airspace e.g. airspace class A to C.	V2
PJ.10-06	**Generic' (non-geographical) Controller Validations:** The solution refers to the development of advanced tools and concepts that will help to remove the qualification constraints imposed on ATCOs for controlling a single volume of airspace. This approach would allow ATCOs to operate in any airspace classified as a particular type. **Expected performance benefits:** The solution aims at improving cost efficiency (ATCO productivity) by improving sector team organization and human performance aspects.	V1
PJ.11-A1	**Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations - ACAS Xa** The solution refers to the use of ACAS Xa, an airborne collision avoidance system, which takes advantage of optimised resolution advisories and of additional surveillance data, without changing the cockpit interface (i.e. same alerts and presentation in the current TCAS). **Expected performance benefits:** The solution aims at improving safety.	V3

Solution ID	Solution name and description	Target maturity level
PJ.11-A2	**Airborne Collision Avoidance for Remotely Piloted Aircraft Systems – ACAS Xu:** The solution ACAS Xu provides airborne collision avoidance to RPAS, building on optimised resolution advisories and additional surveillance data, while taking into account the operational specificities of RPAS (the additional surveillance sources could be ADS-B but also any other sensor installed on the RPAS). **Expected performance benefits:** The solution aims at improving safety by preventing Near Mid-Air Collision for RPAS. The preliminary analysis of ACAS Xu alerting in today's operational mixed-equipped scenarios shows that ACAS Xu will typically alert more often and earlier than manned aviation systems (TCAS II or ACAS Xa).	V2
PJ.11-A3	**ACAS for Commercial Air Transport specific operations - ACAS Xo** ACAS for Commercial Air Transport specific operations - ACAS Xo improves ACAS (Airborne Collision Avoidance System) building on optimised resolution advisories and additional surveillance data, while avoiding unnecessary triggering of resolution advisories (Ras) in new separation modes (e.g. ASAS), in particular if lower separation minima are considered. **Expected performance benefits:** The solution aims at improving safety.	V2
PJ.11-A4	**Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp:** The solution ACAS Xp provides Airborne Collision Avoidance to General Aviation and Rotorcraft, taking into account their limited capability to carry equipment and their operational specificities. The scope addressed in Release 8 relates to the Enhanced Traffic Situation Awareness with Alerting (TSAA+) capability. The introduction of TSAA+ is expected to improve safety due to: • Less near mid-air, and mid-air collisions; • Decreased GA/H/military vs. TCAS II-equipped contradictory manoeuvring risk.	V2
PJ.11-G1	**Enhanced Short Term Conflict Alert (STCA) and Non Transgression Zone (NTZ) Ground Based Safety Nets making use of DAPs information:** The solution refers to ground based safety nets for SESAR future trajectory management and new separation modes through the use of wider information sharing and new surveillance means **Expected performance benefits:** The solution aims at improving safety.	V2

Solution ID	Solution name and description		Target maturity level
	Optimised ATM network services		
PJ.07-01	**AU Processes for Trajectory Definition:**		V2
	This solution is focusing on refining operational requirements for the Planning Service, so as to provide additional benefits to the Airspace Users for requesting the Planning Service from the Network Management Function, with the assumption that the Network Management Function will become the FF-ICE Planning Service Provider for the ICAO European Region. This solution includes refining timing operational requirements for submitting preliminary flight plan desired 4D trajectory information to the Network Management Function, so as to improve the outcome of the ATFCM/ASM process for the benefit of the Airspace User.		
	Expected performance benefits:		
	The SESAR solution aims at improving fuel efficiency, predictability and cost-efficiency.		
PJ.07-01-01	**Reactive Flight Delay Criticality Indicator (FDCI)**		V3
	The Flight Delay Criticality Indicator [FDCI] is a parameter provided by the Airspace User to indicate that it is critical that the flight progresses and arrives on time. Hence, the flight should preferably not be assigned any or much delay and it should even be tried to decrease an allocated delay if accepted and possible. The solution addressed the reactive FDCI that means the FDCI flight has an ATFCM delay and slot already issued.		
	Expected performance benefits:		
	The SESAR solution aims at improving fuel efficiency, predictability and cost-efficiency.		
PJ.07-02	**AU Fleet Prioritization and Preferences (UDPP)**		V2
	Airspace Users' Fleet Prioritisation and Preferences (UDPP) sees the extension of airspace user capabilities, through the UDPP, allowing them to recommend a priority order request to the NM and appropriate airport authorities for flights affected by delays on departure, arrival and en-route, and to share preferences with other ATM stakeholders in capacity-constrained situations (CCS).		
	Expected performance benefits:		
	The SESAR solution aims at improving fuel efficiency, predictability and cost-efficiency.		
PJ.08-01	**Management of Dynamic Airspace configurations:**		V2
	The solution refers to the development of the process, procedures and tools related to Dynamic Airspace Configuration (DAC), supporting Dynamic Mobile Areas of Type 1 and Type 2. It consists of the activation of Airspace configurations through an integrated collaborative decision making process, at national, sub-regional and regional levels; a seamless and coordinated approach to airspace configuration, from planning to execution phases, allowing the Network to continuously adapt to demand pattern changes in a		

Solution ID	Solution name and description	Target maturity level
	free route environment) and ATC sectors configurations adapted to dynamic TMA boundaries and both fixed and dynamic elements. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.	
PJ.09-01	**Network Prediction and Performance** Network Prediction and Performance relies on shared situational awareness with respect to demand, capacity and performance and has an impact on regional, sub-regional and local demand and capacity balancing (DCB) processes. It consists of improved traffic and demand forecast based on SBT and the computation of confidence indexes. Prediction of DCB constraints and complexity issues will be based on the definition of metrics and algorithms for prediction, detection and assessment of traffic complexity, thus improving the accuracy and credibility of the diagnosis and awareness of hotspots. Network Operations will be monitored through Network Performance KPA/KPI while a Network impact assessment will analyse trade-offs and facilitate collaborative decision making processes. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.	V2
PJ.09-02	**Integrated Local DCB Processes** Integrated Local DCB Processes see the seamless integration of local network management with extended ATC planning and arrival management activities in short term and execution phases. It represents the core functionality for the Integrated Network ATM Planning (INAP) process through an enhanced Local DCB tool set. The solution will improve the efficiency of ATM resource management, as well as the effectiveness of complexity resolutions by closing the gap between local network management and extended ATC planning. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.	V2
PJ.09-03	**Collaborative Network Management Functions** Collaborative Network Management Functions allow for network management based on transparency, performance targets and agreed control mechanisms. The solution enables a real-time visualisation of the evolving AOP/NOP planning environment (such as demand pattern and capacity bottlenecks) to support airspace user and local planning activities. Network Operations planning and execution is managed by an agreed set of rules and procedures (including what-if), guiding subsidiary DCB and UDPP measures under consideration of trade-offs and network performance targets. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.	V2

Solution ID	Solution name and description		Target maturity level
PJ.09-03-01	**ECASA** ECASA (Enhanced CASA) is a new optimisation mechanism referred that aims at minimising the delays. Briefly, the new method takes CASA as a baseline (including the FPFS policy) and applies targeted slot amendments to certain cherry-picked flights. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.		V3
PJ.09-03-02	**AOP/NOP departure information integrated in eFPL** The solution provides a harmonised and improved integration of AOP/NOP departure information in trajectories calculated by FOCs and NM. The alignment of the AU, NMF and airport views of 4D trajectories in planning phase and increase predictability by exchanging dynamic AOP/NOP departure information – in particular runway configurations in use, departure taxi times, planned runways and SIDs - allow the FOC to plan and share a more accurate and up-to-date 4D trajectory. **Expected performance benefits:** The SESAR solution aims at improving airspace capacity, fuel efficiency, predictability and cost-efficiency.		V3
	Enabling aviation infrastructure		
PJ.14-02-01a	**FCI Terrestrial Data Link Air to Ground Functionality** The solution refers to the future Terrestrial Data Link, which includes L-band digital aeronautical communications system (L-DACS) and digital voice. This solution covers the Air to Ground functionality **Expected performance benefits:** The SESAR solution aims at improving capacity, efficiency, safety and resilience of the current CNS infrastructure.		TRL-4
PJ.14-02-01b	**FCI Terrestrial Data Link - Air to Air Functionality** The solution refers to the future Terrestrial Data Link, which includes L-band digital aeronautical communications system (L-DACS) and digital voice. This solution covers the Air to Air functionality **Expected performance benefits:** The SESAR solution aims at improving capacity, efficiency, safety and resilience of the current CNS infrastructure.		TRL-2

Solution ID	Solution name and description	Target maturity level
PJ.14-02-02	**Future Satellite Communications Data link** The solution enables data communications in oceanic and remote regions and as a complement to terrestrial systems. The development will be carried out in cooperation with the European Space Agency Iris programme. The project also did complementary work to consolidate TRL-6 on solution #102 (SESAR 1) **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-4
PJ.14-02-04	**FCI Network Technologies incl. voice solutions and military interfacing:** The solution sees the migration towards Internet protocol, enabling network-centric SWIM architectures, interfacing with military. **Expected performance benefits:** The SESAR solution aims at improving capacity, efficiency, safety and resilience of the current CNS infrastructure together with a positive economic impact on the deployment of the overall future communications system.	TRL-4
PJ.14-02-05	**Development of new services similar to FIS-B to support ADS-B solutions for General Aviation:** The solutions aims at developing new services similar to Flight Information System-Broadcast (FIS-B) to support Automatic Dependent Surveillance - Broadcast (ADS-B) solutions for General Aviation such as broadcast (ADS-B) solutions for GA. **Expected performance benefits:** The SESAR solution aims at improving safety through the provision of real-time traffic information and updated weather data during flight that will allow safe GA pilots' decisions in due time (e.g. diversions to alternate routes or airports) and avoidance of unauthorised airspace penetration due to better planning information available in real time, allowing for early decisions regarding the flight execution.	V2
PJ.14-02-06	**AeroMACs integrated with ATN, Digital Voice and Multilink** The solution completed the development of AeroMACS with trial deployment(s) at airport(s) with multiple mobile users at the same time integrating AeroMACS on vehicles and EFB equipped aircraft, to support validation of other potential usages of the AeroMACS data link to support especially (VoIP) digital voice communication and multilink and to prepare/support the consideration of the AeroMACS enabler in VLD(s) demonstrating the AeroMACS capabilities with involving airport(s) and Airlines. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-6

Solution ID	Solution name and description		Target maturity level
PJ.14-03-01a	**GBAS GAST D Extended Scope** The solution sees the finalisation of the development of GBAS CAT III L1 (GBAS approach service type (GAST-D)): adverse ionospheric conditions and conditions outside the mid latitudes (high and low latitude issues) and Large and complex airport environments The solution also addressed GBAS Expanded Service Volume (ESV) and increased Dmax requested by airspace users beyond 23 Nautical Miles from a technical perspective (looking at the GAST D availability as a function of Dmax range. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.		TRL-4
PJ.14-03-01b	**GBAS GAST F** GBAS robustness and performance enhancement by means of Dual Frequency Multi Constellation GNSS (GALILEO). **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.		TRL-2
PJ.14-03-01c	**GBAS Non-MMR Avionics Architecture** An airborne segment activity to derive a non-MMR (Multi Mode Receiver) architecture design for non-mainline aircraft targeting CATII/III operations supported by xLS guidance including GAST D and GAST F. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.		TRL-2
PJ.14-03-02	**Multi Constellation / Multi Frequency (MC/MF) GNSS** The solution refers to standardisation developments for multi-constellation GNSS (GALILEO). **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.		TRL-4
PJ.14-03-04	**RNP1 reversion based on DME-DME** Solution addresses the need to introduce ground and airborne systems that can support currently defined and standardized PBN and other CNS-based operations and provide a backup with the required level of performance in case of corruption, degradation and absence/loss of GNSS. The short term A-PNT thread seeks to enhance DME/DME/IRS to provide a navigation reversion mode targeting RNP. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.		TRL-6

Solution ID	Solution name and description	Target maturity level
PJ.14-03-04b	**Mid-Term Alternative Position, Navigation and Timing** Solution addresses the need to introduce ground and airborne systems that can support currently defined and standardized PBN and other CNS-based operations and provide a backup with the required level of performance in case of corruption, degradation and absence/loss of GNSS. The mid-term thread investigates the improvements in multi-DME localization algorithms fully compliant with RNP requirements. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-4
PJ.14-03-04c	**Long-Term Alternative Position, Navigation and Timing** Solution addresses the need to introduce ground and airborne systems that can support currently defined and standardized PBN and other CNS-based operations and provide a backup with the required level of performance in case of corruption, degradation and absence/loss of GNSS. The long-term activities target to include future terrestrial technologies in next generation of A-PNT infrastructure. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-2
PJ.14-04-01a	**Surveillance Performance Monitoring - Cooperative and non-Cooperative sensor** The solution addresses new surveillance systems wide area multilateration (WAM), INCS (SMR), ground and space-based ADS-B. This Solution focuses on SPM Tools specifications and applies at the individual "sensor" level. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-4
PJ.14-04-01b	**Surveillance Performance Monitoring - End-to-End Surveillance Chain** The solution addresses new surveillance systems wide area multilateration (WAM), INCS (SMR), ground and space-based ADS-B. This solution focuses on SPM Tools specifications and applies at ATC "end-to-end" level (input to the controller working position). **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-2

Solution ID	Solution name and description	Target maturity level
PJ.14-04-03	**New use and evolution of Cooperative and Non-Cooperative Surveillance** The solution develops new use and evolution of Cooperative and Non-Cooperative Surveillance for ATM and A-SMGCS purposes. **Expected performance benefits:** The SESAR solution aims at achieving the SESAR objectives on service and performance based CNS.	TRL-4
PJ.15-01	**Sub-regional Demand Capacity Balancing Service** The Sub-regional Demand Capacity Balancing Service aims at facilitating an improved usage of the airspace at sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed. **Expected performance benefits:** The solution aims at improving cost-efficiency.	TRL-6
PJ.15-02	**E-AMAN Service** The E-AMAN Service operates the AMAN functionalities within an extended horizon to provide local and overall arrival sequences for planning and tactical operational purposes in a cross border environment. **Expected performance benefits:** The solution aims at improving cost-efficiency.	TRL-6
PJ.15-08	**Trajectory Prediction Service** The Trajectory Prediction Service aims at computing and distributing an accurate and consistent 4D trajectory and update it as the flight progresses. The output could be used during different flight phases: to propose an initial reference trajectory in the planning phase, as input for DCM during the tactical phase or facilitate transfers during the operations phase. **Expected performance benefits:** The solution aims at improving cost-efficiency.	TRL-0
PJ.15-09	**Delegation of airspace and contingency:** Delegation of airspace and contingency aims at developing virtual centres for supporting different possible delegation of airspace amongst ATSUs based on traffic / organization needs or contingency needs. **Expected performance benefits:** A fundamental goal of the Single European Sky initiative is to "provide ATM services to airspace users at a cost of at least 50 % less". The notion of Common Service aims to contribute to this goal. Common Services, defined as "a service that provides capability to consumers in the same way that they would otherwise need to provide themselves", aims to mitigate this issue.	V1

Solution ID	Solution name and description	Target maturity level
PJ.15-10	**Aeronautical Data Service** The Aeronautical Data Service function is to provide static and dynamic aeronautical data in digital form to be used by different ATM systems (e.g. Safety Nets). The output is an AIXM-compliant dataset whose subsets can be retrieved by individual requests demanding specific geographical areas, attributes or functional features. **Expected performance benefits:** The solution aims at improving cost-efficiency.	TRL-6
PJ.15-11	**Aeronautical Digital Map Service** The Aeronautical Digital Map Service provides digital maps ready to be used by different ATM systems (e.g. Safety Nets) when performing separation functions. The output is highly customizable in order to meet the different requirements from the consumers and easily convertible among different digital formats, as AIXM, GML, XML, etc. **Expected performance benefits:** The solution aims at improving cost-efficiency.	TRL-6
PJ.16-03	**Work Station, Service Interface Definition & Virtual Centre Concept:** The solution will provide an operating environment in which different ATS units, even across different ANSPs, will appear as a single unit and will be subject to operational and technical interoperability. It includes the development of the ATSU architecture from a service oriented approach with a focus on the technical services and common interfaces. Based on the Virtual Centre concept, the CWP/HMI needs to interface with multiple ATM Data Service Providers (ADSPs). A high performing and reliable underlying communication infrastructure may be needed. This solution encompasses en-route and TMA and airport/TWR environments. **Expected performance benefits:** The solution aims at enabling Europe to move to an interoperable, cost-efficient and flexible service provision infrastructure. Decoupling of the CWPs should enable a more efficient use of the most valuable and expensive resource, the human. By enabling increased flexibility the ANSPs should better manage staffing for prevailing traffic conditions and assure service continuity.	TRL-6
PJ.16-04	**Workstation, Controller productivity:** The solution includes the development of new human machine interface (HMI) interaction modes: Multi-Touch Inputs (MTI), Automatic Speech Recognition (ASR), Attention Guidance (AG), User Profile Management Systems (UPMS), and Qualification of CWP Virtualisation (CWPV). **Expected performance benefits:** The solution aims at improving the ATCO productivity thanks to the new HMI interactions that would increase automation and reduce ATCO actions.	TRL-4

Solution ID	Solution name and description	Target maturity level
PJ.16-04-01	**Multi Touch Input (MTI)** The rise of multi-touch technology such as tablets or smart phones has heralded a new form of data input technologies which are now becoming second nature to, and in some cases preferred to traditional input methods. This technology has been demonstrated to provide much faster input methods including methods such as 'one-touch' cleared flight levels or graphical routing via touch opportunities. The technology also allows for the exploitation of even more complex and useful tools such as map manipulation directly via touch inspired by mobile mapping apps and gestures recognition for tactical inputs in order to enhance usability and controller productivity. **Expected performance benefits:** The solution aims at improving the ATCO productivity thanks to the new HMI interactions that would increase automation and reduce ATCO actions.	TRL-4 (ready for industrialization, no additional R&D needed)
PJ.17-01	**SWIM TI Purple Profile for Air/Ground Advisory Information Sharing:** The solution supports ATM operational improvements that depend on A/G information exchanges to enable better situational awareness and collaborative decision-making. This includes the specification of technical architecture and functions that are required to achieve full interoperability between air and ground SWIM segments and meet the safety and performance requirements required by airborne operations. **Expected performance benefits:** PJ.17-01 solution supports ATM operational improvements that depend on Air/Ground (A/G) information exchanges to enable a better situational awareness and collaborative decision making, with a focus on advisory information. The solution aims at contributing positively to global interoperability by designing and validating in collaboration with EU members innovative and open standards based solution for the integration of the Aircraft into the SWIM "network", ensuring that safety and security requirements are met.	TRL-6 (maturity gate planned in 2020)
PJ.17-03	**SWIM TI Green profile for G/G Civil Military Information Sharing:** The solution ensures that protocols and data models used in military systems can be interfaced with SWIM with adequate quality of service levels maintained. It will complement the Air/Ground SWIM Purple Profile for advisory services. **Expected performance benefits:** The solution aims at improving civil-military coordination and cooperation supporting a wide range of SWIM services covering military expectations.	TRL-4 (maturity gate planned in 2020)
PJ.18-02a	**Trajectory based operations:** This ATM solution will mature all long-term elements related to Trajectory Based Operations including but excluding specific planning aspects studied in PJ09 or PJ07. It will therefore concentrate on RBT management and the last phase of SBT, once flight plan filing has occurred.	V1

Solution ID	Solution name and description	Target maturity level
	Expected performance benefits: The solution aims at improving capacity, predictability, fuel efficiency, safety and cost-efficiency.	
PJ.18-02b	**Flight object interoperability:** The solution consists of the definition of the IOP Solution, based on the SESAR 1 Solution #28. The IOP scope has been divided into a Basic scope, sufficient to deploy IOP in the core area of Europe, and the Full scope, which provides additional IOP functionalities**.** **Expected performance benefits:** The solution aims at improving interoperability and safety, and supports further operational benefits e.g. airspace capacity.	TRL-6 (maturity gate planned in 2020)
PJ.18-02c	**eFPL supporting SBT transition to RBT** This Technological Solution will look at the distribution of eFPL information to ATC systems, and at the possible improvements of the alignment of AUs' and NM's trajectories especially concerning use of PTR s and Standard Instrument Departure (SID)/Standard Arrival Route (STAR) allocation. **Expected performance benefits:** The solution aims at improving interoperability and safety, and supports further operational benefits e.g. predictability and fuel efficiency.	TRL-6
PJ.18-04a	**Aeronautical Information Management (AIM) information** The solution defines and delivers technically validated AIM Information Services for identified Operational Solutions. The Solution aims to achieve the following objectives: • Enhancing the operations, process or systems –generally referred to as 'capabilities'- that provide AIM information; • Providing AIM information as a SWIM-based information exchange service to a specific Operational Solution; • Contributing to potential operational validation exercise that consumes a developed AIM information exchange service **Expected performance benefits:** The solution aims at supporting operational benefits e.g. predictability and fuel efficiency in other ATM solution.	TRL-6 (maturity gate planned in 2020)
PJ.18-04b	**Meteorological (MET) information** The solution defines and delivers technically validated MET Information Services for identified Operational Solutions. The Solution aims to achieve the following objectives: • Enhancing the operations, process or systems –generally referred to as 'capabilities'- that provide MET information; • Providing MET information as a SWIM-based information exchange service to a specific Operational Solution;	TRL-6 (maturity gate planned in 2020)

Solution ID	Solution name and description	Target maturity level
	• Contributing to potential operational validation exercise that consumes a developed MET information exchange service. **Expected performance benefits:** The solution aims at supporting operational benefits e.g. predictability and fuel efficiency in other ATM solution.	
PJ.18-04c	**MET and AIM information services in the aircraft information domain** The solution defines and delivers a validated Technological Solution supporting the acquisition, processing and distribution of MET and AIM information and the representation of this information to airspace users. With the objective to support (later) operational validation of improved situational awareness, improved strategic trajectory management and improved collaborative decision making (all) based on a better enabled airspace user participation in these processes. The Solution aims to achieve the On-board acquisition, processing and distribution of MET and AIM information and other operational information including the interpretation and representation of this information within the aircraft. **Expected performance benefits:** The solution aims at improving pilot's situational awareness and safety..	TRL-4 (maturity gate planned in 2020)
PJ.18-06a	**Air Traffic Control (ATC) Planned Trajectory Performance Improvement** The solution aims at improving planned trajectory predicted by Trajectory Prediction & Management (TP&M) thanks to the usage of new ADS-C reports and new surveillance parameters. Detailed flight plan information from FOC (FIXM) will be analysed in order to complement the aircraft information. **Expected performance benefits:** The solution aims at supporting operational benefits e.g. predictability and fuel efficiency in other ATM solution.	TRL-6 (maturity gate planned in 2020)
PJ.18-06b	**Tactical and Network Manager (NM) Trajectory performance Improvement:** The solution aims at improving the tactical and NM trajectories predicted by TP&M thanks to the usage of new ADS-C reports. As part of 18-06b tactical trajectories predicted by TP&M they will be improved thanks to the usage of some data elements from ADS-C reports**.** **Expected performance benefits:** The solution aims at supporting operational benefits e.g. predictability and fuel efficiency in other ATM solution.	TRL-4 (maturity gate planned in 2020)

Table 3: Planned outcome of the Release 9

In addition, 4 VLDs performed demonstration activities in the Release 9 timeframe:

PJ.24 aimed to demonstrate the maturity of NCM elements validated in the SESAR1 projects and to show network performance benefits in a larger part of Europe. The concept elements included were ATFCM measures such as level-capping, airport - network planning integration and target times measures, and improved data exchange linking network and local tools. In addition, NCM included elements that were close to operational introduction, such as regulation proposals via B2B, targeted

flow regulation using improved ATFCM NM Scenario Repository, flight improvements through exclusions and forced CTOTs.

Demonstrations exercises have been performed in 2016-2019 , in a large part of Europe, involving 8 different ANSP's, 4 major airports, the European Network Manager, major European airlines (the Airline TEAM) representing about 70% of European air traffic and informal contribution of many other airlines. The demonstration exercises were performed as much as possible in the operational context to be able to confirm operational performance improvements.

The scope under demonstration covered:

- Network Coordination: the identification of a local DCB imbalance (possibly supported by automated local tools) initiate a local/network coordination process between relevant local stakeholders and the network based on pre-defined ATFCM scenario (i.e. ATFCM reroute measures) selections by local FMPs and based on network impact assessments (including What-If simulations). Coordinated implemented scenarios and measures will be monitored by both local stakeholders and NM to verify the operational results.

- Tactical Capacity Management (local level) - The identification of targeted measures to reduce ATFCM delay through optimisation workflow processes supported by integrated data exchange and the introduction of flow- and flight-specific measures as part of the STAM collaborative process in the ANSP local tools (i.e. iFMP, ECOSYSTEM, CAP, iACM and PLANTA).

- Airspace User Collaborative Processes - The intervention of AUs in the decision-making (STAM proposal, priority flights) was explored. Where appropriate, flexibility is given to select, based on minimized business impact, the flights to which specific measures will be applied.

- Airport Network Integration (local/network level) - Airport operations planning information (aligned with current processes as A-CDM, gate management, etc) is exchanged earlier with the network operations planning. Airport arrival requirements are shared with the network to optimize delivery of flights to airports with the aim to improve the usage of limited runway capacity and with the aim to enhance network performance, i.e. delay to airspace users.

PJ.24 has demonstrated network performance benefits as a result of cooperation and better information exchange between operational actors (including Airspace Users) supported by local tools connected to the network. It enabled the application of targeted flow measures and improved cooperation at a European ATM network level with no impact on safety and positive effect on predictability.

Coordination improvements have resulted in massive reductions of time necessary for coordination per measure. This includes the identification, proposal, assessment, feedback and implementation of the measure. A single FMP or NMOC controller was capable of managing many more measure proposals as before, which enables the application of specific flight delay measures.

Over a relatively short period (couple of days/weeks), demonstration exercises were able to show solid delay reductions of hundreds to a few thousand minutes of delay by minimizing the impact of otherwise applied global regulation. In the exercises that included measures to many flights (e.g MUAC flight improvements, or Heathrow's TTA's) delay reductions are estimated to add to thousands of minutes of delay savings.

During the trials, fuel efficiency of impacted flights receiving reroute proposals dropped. Overall, it was estimated that several dozens of kg, sometimes well above 100 kg of additional fuel per flight was required to fly at lower altitudes or re-routing to avoid ATFCM regulations. However, applying targeted measures and avoiding regulation could result in fuel savings. Demonstrations and simulations in the

FABCE area and target time demonstrations at London Heathrow showed opportunities for fuel reduction resulting from more flights on optimal tracks and less holding time because of targeted measures and better managed arrival times.

For airlines, the reduced delay measures results in less impact to the passengers and less financial impact for the company. E.g. if a delayed flight is approaching crew duty time limitation or curfew, reduced delay measures could avoid costly measures as additional ferry flights, or other unplanned flights for positioning.

Overall conclusion of PJ.24 demonstrations is that the cooperative and transparent approach to address current network inefficiencies, and to apply flight- and flow-specific targeted measures supported by integrated system-supported coordination processes, leads to significant network performance benefits.

PJ.25 project has demonstrated, at a very large-scale, new extended arrival management tools and techniques that improve flight efficiency and flight predictability at airports, in TMA, Extended TMA, and in en-route UAC / ACC.

This included the following solutions:

- Extended AMAN between 200 to 350 NM: the main target of xStream is to provide a ready-for-implementation solution for PCP deployment, with an extended arrival management horizon up to at least 200 NM in order to enable delay absorption earlier in the flight and at higher altitude, which is more fuel-efficient. When dealing with high levels of arrival delay, or for pre-sequencing the aircrafts before a detected congestion at the entry of the Extended TMA, this horizon can be extended up to 350 NM for maximum efficiency.

- Also, the concept of target times for airborne long haul flights was applied with a horizon outside of the European Network involving the AU's OCCs in the process.

- Handling of multiple inbound flows to multiple airports in the sectors of upstream ACCs: with the extension of AMAN horizon, the cumulative effect of E-AMAN requests in the same sector may lead to an increase of ATCO workload, because of the competition between the flows, and induced conflicts. To prevent this, a CDM process has to be implemented to better coordinate E-AMAN activities, and assess upstream ACCs ability to deliver the E-AMAN service.

- Improvement of Arrival Planning: by using locally computed Pre-departure Target Time of Arrival sent to Network Manager in addition with a collaborative process to integrate Airspace Users' preferences/priorities, the impact and cost of ATFCM delays can be reduced. TTA allocation also contributes to the arrival management process by enhancing the short-haul adherence to the targeted sequence.

- Integration of Airspace Users Preferences in the arrival planning process, thus limiting the cost of delay for airlines. UDPP and A-FLEX provide an efficient solution to reallocate ATFCM delay in order to optimize arrivals according to Airspace User needs, reducing the impact on Airline operations.

To address these topics, live and shadow mode trials have been performed between July 2017 and October 2019, in order to demonstrate that these concepts are mature enough in high density areas. Demonstrations have been performed in major hub airports: Zurich, Paris CDG & Orly, London Gatwick & Heathrow, and Frankfurt-Main. Details regarding the demonstration exercises that were planned in Release 9 timeframe are available in the Release 9 plan. They involved a large number of ACCs around

those platforms (actually most of ACCs of the Core Area), the Network Manager and airspace users (Lufthansa Group, Air France, British Airways, EasyJet, Ryanair).

These demonstrations were successful and delivered the following operational benefits:

- environmental sustainability:
  - a reduction in airborne holding and vectoring in lower airspace;
  - in the Paris and London demonstrations, fuel savings in the arrival phase, up to 30 kg of fuel per flight (based on BADA estimates), equivalent to a reduction of gas emissions up to 90 kg of CO2 per flight.
- capacity:
  - a reduction of congestion and complexity in TMA, enabling capacity improvements in terminal area during traffic peaks;
  - optimisation of ATFCM constraints, by better matching available capacity with traffic demand;
  - arrival ATFCM delays reduced up to 5% in Paris area.
- flexibility:
  - the ability to integrate Airspace Users priorities in capacity constrained situations or not (arrival streaming); thus allowing optimized hub carrier operations at the destination airport, as well as reducing the cost of ATFCM delay for airlines;
  - through UDPP, ability to reallocate ATFCM delay in order to optimize arrivals according to Airspace User needs, reducing the impact on Airline operations.
- safety: reduction of TMA workload, while maintaining a safe management in upper airspace.
- predictability: Improvement of arrival sequence predictability, allowing a better anticipation of operations for Flow Managers and Supervisors.

PJ.28 has performed demonstration exercises in close to real operational environments during Release 9 timeframe to highlight the applicability of a number of airport related SESAR 1 solutions and encourage their early adoption:

- SESAR Solution #53: Pre-departure sequencing supported by route planning;
- SESAR Solution #22: Automated Assistance to Controller for Surface Movement Planning and Routing and;
- SESAR Solution #02: Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances.

In addition, the PJ.28 project has supported the development of on-board alerting systems in safety related solution e.g. PJ.03b-05: as ADS-B data performance is a key enabler for these systems, the demonstration has provided evidence that the challenges of ADS-B employment for safety net application can be overcome to provide a sound usage of this technology for the intended purpose.

Demonstration have been conducted in passive shadow mode: prototypes have been connected to operational airport systems and used live data during the trials. In addition, local Controllers from the ANSPs and airports took part in the exercises, bringing expert knowledge into the demonstrations.

Main conclusions are the following:

- SESAR Solution #22: Automated Assistance to Controller for Surface Movement Planning and Routing:

  o The routing and planning function was successfully demonstrated, but limitations have been observed related to special pushback procedures and the operational particularities of each airport for which routes are proposed by the systems;

  o The Situational Awareness and the Workload were successfully demonstrated with the new function, with minor exceptions;

  o The route modification capabilities have been successfully demonstrated but are highly dependent on HMI implementation and quality of proposed routes (to keep required modifications to a low level);

  o Predicted Taxi-time accuracy was partially demonstrated and indicated deviations from the real taxi-time when local constraints such as intermediate runway crossings, airline characteristics and pushback procedures were involved.

- SESAR Solution #02: Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances:

  o Conflicting ATC Clearances and Conformance Monitoring safety nets were rated very positively although routing issues were present during demonstration;

  o The Situational Awareness and the Workload are still acceptable with the new function;

  o Quality of position data and correct tuning of the functions are essential for acceptability.

- SESAR Solution #53: Pre-departure sequencing supported by route planning:

  o Good results in Budapest although the Departure Manager was prepared to provide departure, and not pre-departure sequences. Hamburg and Nice could not demonstrate the solution;

  o Very dependent on accurate taxi times;

  o Shadow mode bias might be more significant here – final results related to local implementation.

- ASD-B Data collection: the collection of data was successful and data have been evaluated. All results have been delivered to the project PJ03B to support the further development.

Most of the objectives have been partially demonstrated, indicating that some issues have been discovered and need to be addressed when implementing the functions at airports.

The used shadow mode setup had some bias to the results, but the intermediate step of the VLD was very important to reveal challenges taking the solutions from simulation to real airport operations.

The provision of up-to-date and standardised layout (ASRN) data and related information as a means of enabling the effectiveness of routing solutions and, by extension, airport safety net and departure manager solutions is essential. Therefore, standardized exchange formats developed should be used. In addition, it needs to be pointed out that benefits can only be achieved when local procedures are fully implemented (not only published ones), the data quality the functions are based on is high enough and the Controllers have enough training and familiarisation time with the new functions and the human machine interface).

The demonstration report gathering all the project results is expected to be submitted in Q1 2020.

Project **PJ.31 DIGITS "Initial trajectory information sharing"** has performed a series of demonstration activities in Release 9 timeframe:

- Demonstration exercise #04 (DFS EPP usage) covered three different areas:

  o Acquisition of ADS-C data: addressed the means to get the ADS-C data contents from the aircraft. Its purpose has been to evaluate the technical performance of ADS-C via VDL Mode 2 based ATN Network and consider the implications on ADS-C system requirements and architecture for the future;

  o Characteristics of ADS-C data: addressed the understanding of the content and behaviour of ADS-C data, understanding the meaning of the information, its behaviour, robustness, reliability, precision, across the range of real-world situations of commercial aviation, in interaction with ATC procedures and flight-crew behaviour;

  o Use and application of ADS-C: covered the use of ADS-C applications and requirements for ATC end systems regarding ADS-C (in particular the iCAS System): trajectory information display, A/G Discrepancy Monitoring / 2D Consistency Check and ground TP enhancements.

- Demonstration exercise #05 (ENAV EPP usage) consisted of consists of two main threads: a shadow mode demonstration of the management of ADS-C with revenue flights and an operational evaluation (offline) of the downlinked ADS-C data and the potential benefits on predictability, human performance, safety and efficiency.

- Demonstration exercise #06 (MUAC EPP usage) intention was to display the ADS-C information to a selected group of controllers and perform an evaluation of EPP usage in the normal working environment. ADS-C data was received from the revenue flights, the 2D path + ETAs as in the EPP were displayed on the CWP, and an automated 2D-consistency check of the ground based Flight Plan and the downlinked EPP was provided to the controller.

- Demonstration exercise #07 (NATS EPP usage) consisted of two threads: a shadow-mode demonstration of the management of ADS-C contracts during flight trials, with subsequent offline assessment of the downlinked ADS-C data and an IBP demonstration activity using controllers that aimed to demonstrate the application of EPP in an ATC operation. The primary purpose of the shadow mode was to demonstrate how to manage ADS-C contracts efficiently as a flight progresses from one centre to another. The purpose of the offline analysis was to understand the operational behaviours that impact downlinked ADS-C data in a revenue flight context, and their effect on the usability of EPP data to support ATM processes.

Results of these exercises are currently under consolidation.

A final demonstration exercise #08 revenue flights will be completed in Release 10 timeframe (beyond April 2020). The operational scope of the final demonstration exercise is the collection of ADS-C data from revenue flights and to identify benefit potentials derived from trajectory information sharing based on analysis of a big amount of data stemming from ten thousands of revenue flights under real day-to-day operational conditions in busy central European airspace. The consolidated results of PJ.31 will be documented in the Release 10 close-out report.

These achievements were regularly monitored against plan and reported into the SESAR JU's advisory bodies (see paragraph 2.1.4), notably the Programme Committee.

2.3.1.3 Overall preliminary conclusions on Wave 1

The completion of IR-VLD Wave 1 projects will have resulted in the successful delivery of 30 solutions (as part of Release 9). They reached the necessary level of maturity what makes them available for pre-industrialisation. As the work was discontinued on particular solutions, there was a need to prioritise and select only those, which are able to bring expected benefits and reach V3 maturity within the SESAR 2020 programme timeframe.

SESAR Solutions refer to new or improved operational procedures or technologies that aim to contribute to the modernisation of the European and global ATM system.

In order to deliver solutions ready for pre-industrialisation, the SESAR JU and its members have built a process, known as the release process, where solutions are tested or validated in real operational environments, including direct airport interfaces. The Solutions are validated according to key performance areas such as safety, cost and operational efficiency, capacity and the environment. They can be associated with new or improved operational procedures or technologies that contribute to the modernisation of not only the European but also global ATM system.

During Wave 1, the SESAR programme has accelerated the research and innovation maturity pace: indeed, as can be seen in the table below, a Solution needed on average 10 years of development to reach maturity "ready for deployment" in SESAR 1, while in SESAR 2020 the average required time is six years:

	SESAR 1	SESAR 2020	Reduction
Cumul V1	2	1,96	2%
Cumul V2	5,41	4,25	21%
Cumul V3	9,81	6,63	32%

Table 4: Acceleration of the innovation cycle in SESAR 2020 Wave 1 compared with SESAR 1

2.3.2 Status of SESAR 2020 Wave 2

Maximising the potential of digitalisation is key to the future success of aviation throughout Europe. The aviation industry is being transformed by digitalisation with increasing automation, and exchange of data amongst all parts of the aviation value chain. But this is only the start and digitalisation will play an increasingly important role in the capacity delivery and future safety and efficiency of the aviation industry. SESAR 2020 Wave 2 aims at marking a first significant step for the key European aviation stakeholders who must work together to ensure that the digital transformation of aviation does not become fragmented and pursue game-changing ideas to meet the objectives of the EU's SES and the EU Aviation Strategy, in particular providing the required network capacity to accommodate with the expected traffic growth.

The Wave 2 call for proposals, within the call with reference H2020-SESAR-2019-1[38], was open in January 2019 and closed in April 2019. This call for proposals consisted in two Work Areas dealing respectively with transversal and industrial research activities (Work Area 1 with a maximum budget of EUR 130 981 975) and VLDs (Work Area 2 with a maximum budget of EUR 20.5 million– further described under Subsection 2.4.1.3).

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[38] Call conditions were set out in the SESAR JU annual work programme for 2019. Call documentation is available on the European Commission's Funding and Tenders Portal

Founding Members

2.3.2.1   Launch of IR projects under the Wave 2 call (H2020-SESAR-2019-1)

The evaluation of the proposals was completed in July with the grant agreements prepared and signed by year-end. Thirteen projects, representing a total amount of EUR 130 535 363 (i.e. 99% of the call's maximum amount), have been launched into execution and will deliver their results in the period from 2020 through to 2022.

The Work Area 1 (industrial research and validation) includes the following projects:

- Two transversal steering activities projects:

  - **PJ.19 W2 'Content Integration, Performance management and Business case Development'**: the project coordinates and integrates operational and technical solutions, and as such supports and guides the execution of the transversal processes (e.g. safety, security assessment, CBA) to ensure their completeness, consistency and coherency from a holistic perspective. The content Integration activities also covers the maintenance and support of the performance framework and ensuring its applicability by the projects.

  - **PJ.20 W2 'Master Planning'**: the master planning (MP) project is the programme focal point to ensure the maintenance and evolution of the European ATM Master Plan. It consists of the yearly update of Level 2 and 3 Plans and Reports, updating and publishing as and when necessary the ATM-MP Level 1.

High-performing airport operations

- **PJ.02 W2 'Airport airside and runway throughput'**: the project intends to improve the efficiency of runway operations and their resilience in visually and/or meteorological challenging conditions and to fully integrate surface management tools with other systems including runway occupancy time prediction, wake separation, arrival and departure management (AMAN/DMAN) systems. It also aims at further reducing the number of incidents / accidents at the airport (e.g. collisions on the apron and taxiway with traffic and/or fixed obstacles).

- **PJ.04 W2 'Total airport management'**: the project aims at enhancing the collaborative airport performance planning and monitoring processes, in particular, through the inclusion in the airside processes of the relevant landside (passenger and baggage flow) process outputs. It also considers the connectivity and multi-modality aspects and the extension of turn-round monitoring within the APOC with the use of digital data management.

- **PJ.05 W2 'Digital technologies for Tower'**: the project addresses the development of new human machine interface (HMI) interaction modes and technologies (e.g. voice recognition, virtual and augmented reality) in order to minimise the load and mental strain on the Tower controllers. It also ensures the application of these technologies for a further development of the Remote Tower Centre (RTC) operations enabling connections between multiple RTCs.

Advanced air traffic services

- **PJ.01 W2 'Enhanced Arrival and Departures'**: the project addresses the management of TMA/E-TMA traffic taking advantage of predicted demand information provided by local Arrival and Departure Management systems to identify sector/route over-demand or additional capacity and balance the sector/flow load. It also examines methods that enable better integration of rotorcraft into the new ATM systems and interoperability with GA, drones and RPAS.

- **PJ.10 W2 'Separation Management and Controller Tools'**: the project further addresses the flight centric ATC procedures in En-route where several flights are assigned to a controller, unconstrained by geographical location, sector or national boundaries and the impact on the controller. It also further considers the operational use cases in particular for the delegation of ATS taking benefit of the virtual centre concept.

- **PJ.13 W2 'IFR RPAS'**: the project covers the IFR RPAS integration in controlled airspace mainly used by Airlines (Classes A to C) by developing a framework for the insertion of RPAS into the non-segregated airspace, allowing their routine access and operations. It also develops a detect and avoid (DAA) system for IFR RPAS operations that will allow the Remote Pilot (RP) to contribute to safety by preventing collisions in case the normal separation provisions fail.

- **PJ.18 W2 '4D skyways'**: the project mainly covers an improvement of the 4D trajectory prediction, in particular with the use of aircraft trajectory data (downlinked ADS-C EPP information) and improved meteorological information with the aim of increasing the traffic predictability and the performance of the ATM processes and tools (e.g. Conflict Detection and Resolution).

Optimised ATM network services

- **PJ.07 W2 'Optimised airspace users operations'**: the project covers an enhanced integration of the AU trajectory and the mission trajectory within the network management processes with the aim of better including the civil and military airspace users within the ATM collaborative processes.

- **PJ.09 W2 'Digital Network Management Service'**: the project mainly addresses the improved use of airspace capacity for both civil and military users by increasing the granularity and the flexibility in the airspace configuration and management within and across ANSPs' areas of responsibilities. Increased digital information will be made available within the Network Operational Plan to ensure a more up-to-date real time ATM situational awareness to be shared with all actors (e.g. traffic forecast, traffic complexity representation).

Enabling aviation infrastructure

- **PJ.14 W2 'Integrated CNSS'**: the project mainly develops an integrated suite of CNS solutions to overcome the inefficiencies of fragmented services while improving the operational efficiency of the ATM system in the short, medium and long term. In the Communication area, it covers multilink technologies to enable the digital transfer of flight critical data and voice communications between aircraft and ground ATM services in a resilient, secure and timely manner. For the Navigation, it includes the development of satellite navigation based robust positioning for all phases of flight, taking advantage of signals from multiple constellations, including Galileo. In the Surveillance domain, it harmonizes and integrates cooperative and emerging non-cooperative sensors, advanced multi-sensors data fusion capabilities, security related functionality together with the methods and tools for Surveillance Performance Monitoring.

2.3.2.2   Release 10 planning

The planning of Release 10 was subject to the launch of the Wave 2 projects in execution. Therefore, the content of the Release 10 will be defined accordingly during Q1 2020. The initial plan is that Release 10 would deliver five candidate solutions in V1/TRL2 level of maturity, five in V2/TRL4 and two in V3/TRL6.

2.4 Strategic Area of Operation 4: Deliver very large-scale demonstration activities (VLD)

The SESAR JU met all its objectives related to very large-scale demonstrations in 2019. This includes the following achievements and results:

- *Call reference H2020-SESAR-2015-2 (IR-VLD Wave 1 call for proposals) –Wave 1 VLD activities delivery of results: two VLD Wave 1 projects (50%) were in execution, completed the delivery of their final results and were formally closed in 2019, and two (50%) were still in execution at the end of 2019 (see Subsection 2.4.1.1)*
- *Call reference SESAR-2017-1 (VLD Geo-fencing call for proposals) – delivery of results: the Geosafe project delivered its final results and was closed in 2019 (see Subsection 2.4.2.1)*
- *Call reference H2020-SESAR-2016-2 (VLD Open 1 call for proposals) – delivery of results: four projects (40%) delivered their final results and were formally closed in 2019, five projects (50%) delivered results and will complete their delivery in 2020, one project (10%) will be launched into execution after a successful grant agreement preparation phase completed in 2019, and will deliver its results until 2021 (see Subsection 2.4.1.2)*
- *Call reference CEF-SESAR-2018-1 (U-space call for proposals) – delivery of results: six projects completed their demonstration exercises and will be closed in 2020 (see Subsection 2.4.2.2)*
- *Call reference H2020-SESAR-2019-1 (IR-VLD Wave 2 call for proposals) – launch, evaluation and award of the VLD activities: for one VLD project (33%) selected as a result of the Wave 2 evaluation process, the grant agreement preparation process concluded successfully and this project was launched into execution on the 1st December 2019; two additional VLD projects (66%) were still in the grant agreement preparation phase at the end of 2019 (see Subsection 2.4.1.3)*
- *Call reference H2020-SESAR-2020-1 (VLD Open 2 call for proposal) – call material preparation (technical aspects): the definition of the VLD Open 2 call for proposals was completed at the end of 2019, and the call is ready to be launched in Q1 2020 (see Subsection 2.4.1.4)*

In 2019, the SESAR 2020 programme performed close to 60 demonstration exercises that provide evidence of the effective delivery of users by SESAR projects in real-life environment. These address in particular the areas of airports, network management, cross-border en-route management and U-space, involving all kinds of stakeholders including airspace users and operators.

2.4.1 Activities carried out under the Horizon 2020 framework

2.4.1.1 Outcomes of Wave 1 VLD projects in 2019 (Call H2020-SESAR-2015-2)

The VLD project **PJ.28 IAO** 'Integrated Airport Operations', had performed all the planned demonstration exercises by the end of 2019 as follows:

- EXE-01: the demonstration at Nice airport took place in April 2019 as a passive shadow mode exercise (i.e. the ATCOs involved in the exercise could receive live data and listen to the radio communications at Nice airport, but their interactions with the system had no incidence on the live operations). The exercise covered the following SESAR 1 mature solutions (PCP AF#2):

  - Solution #02 'Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances';

  - Solution #22 'Automated assistance to controller for surface movement planning and routing';

  - Solution #53 'Pre-departure sequencing supported by route planning';

- EXE-02: this exercise aimed at providing evidence that the performance of real ADS-B data is sufficient to support the function of on-board alerting technology. The function uses ADS-B technology to get information about surrounding traffic so the ADS-B data performance is a key enabler for its proper functions. Five A320 family aircraft of three different airlines were equipped to collect the relevant ADS-B data from March 2018 to April 2019. The data was then analysed to assess that its performance supports correct function of the on board traffic alerting system. The results of this exercise supported SESAR 2020 solution PJ.03b-05 'Traffic alerts for pilots for airport operations';

- EXE-03: the demonstration at Budapest airport took place in April 2019 as a passive shadow mode exercise (i.e. the ATCOs involved in the exercise could receive live data and listen to the radio communications at Nice airport, but their interactions with the system had no incidence on the live operations). The exercise covered the following SESAR 1 mature solutions (PCP AF#2):

  - Solution #02 'Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances';

  - Solution #22 'Automated assistance to controller for surface movement planning and routing';

  - Solution #53 'Pre-departure sequencing supported by route planning';

- EXE-04: the demonstration at Hamburg Helmut Schmidt Airport took place in March 2019 as a passive shadow mode exercise (i.e. the ATCOs involved in the exercise could receive live data and listen to the radio communications at Nice airport, but their interactions with the system had no incidence on the live operations). The exercise covered the following SESAR 1 mature solutions (PCP AF#2):

  - Solution #02 'Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances';

  - Solution #22 'Automated assistance to controller for surface movement planning and routing';

  - Solution #53 'Pre-departure sequencing supported by route planning'.

The demonstration report gathering all the project results is expected to be submitted in Q1 2020. Initial results presented at final communication event held at Hamburg airport in September 2019 showed that:

- The demonstrations had some limitations due to the technique used (passive shadow mode for safety reasons), the limited time to train the participating ATCOs and the time constraints to integrate and test all three sites;

- Constantly changing airport layouts (e.g. construction works) confirm the for standardised and up-to-date airport information;

- It is essential to adapt the new systems and their algorithms to the local procedures, areas of ATCO responsibility and, as much as possible, working methods. This adds complexity and variability in the implementation of the solutions (one size does not fit all);

- The human factor is essential in the successful deployment of the new solutions;

- The solutions seem to provide the expected benefits 'in real life'.

In addition, the EX-03 proved that ADS-B performance was sufficient to support PJ.03b-05 'Traffic alerts for pilots for airport operations', helping to deliver this solution at the V3 maturity level.

The VLD project **PJ.31 DIGITS** 'Initial Trajectory Information Sharing' supplemented by **DIGITS-AU** aims at demonstrating the ATM benefits that can be realised through the usage of downlinked 4D trajectory data (EPP) in ground systems. The project plans to validate the downlinking of ADS-C/EPP data according to ATN baseline 2 standard. Complementing the project PJ.31, the Project DIGITS-AU aims at using the avionics supporting ADS-C/EPP in eight airlines and at demonstrating its use in the airspace of DFS, ENAV, Maastricht Upper Air Centre and UK NATS. Consequently, PJ.31 DIGIT will capture and analyses the big data stemming from the DIGITS-AU flights.

The DIGITS and DIGITS-AU projects therefore jointly propose the following demonstration activities in Europe:

- The airborne industry will develop up to certification the worldwide first airborne unit capable of downlinking ADS-C data according to ATN Baseline 2 standard in compliance with PCP AF#6 (Initial Trajectory Information Sharing).

- The ANSPs and ground industry will build up validation and pre-operational system platforms capable of receiving and processing ADS-C data including the Extended Projected Profile (EPP). For MUAC, this will be implemented in the operational system, whilst for DFS, ENAV & NATS, it will be integrated into their test platforms

- DIGITS plans to have revenue flights becoming available. These commercial flights will downlink ADS-C data to be processed in ATM ground systems of participating ANSPs, covering together a substantial part of European airspace and air traffic under a variety of operational conditions in order to demonstrate the Operational Benefits of Initial Trajectory Information Sharing:

- DIGITS will contribute to reinforce the "Enabling Aviation infrastructure" key feature of SESAR 2020 by demonstrating the ATM benefits that can be realized through the use of downlinked 4D trajectory data in ground systems.

The certification of the EPP package delay (external to the project) for the airline FMS was delivered to March 2019 resulting in a 6 months extension to June 2020 for both PJ31 DIGITS and DIGITS-AU

Grant Agreements, in order to ensure the targeted number of aircrafts and required number of data collecting flights could be achieved. The new certification addressed both Forward Fit (FF) and Retrofit (RF) of on-board equipment.

DIGITS-AU is the Airspace User complementary project, with the participation of six airspace users companies. It is targeted to upgrade - either during final assembly or through retrofit - up to 100 A320 family aircraft with enhanced communication and surveillance capability compliant with the new Aeronautical Telecommunications Network Baseline 2 (ATN-B2) standard through the Airbus Future Air Navigation System (FANS C) avionics and to establish Automatic Dependent Surveillance Contracts (ADS-C) on about 20 000 revenue flights. DIGITS-AU started in Jan-2018 and will end together with DIGITS in Jun-2020. As of September 2019, nearly 2000 successful DIGITS flights were registered involving 18 aircraft from two airlines. This increased to 28 aircraft and over 4 000 successful DIGITS flights registered by the end of the year.

In the frame of DIGITS, MUAC with the aid of ground industry partners, adapted its operational system while DFS, ENAV and NATS have built up shadow-mode system platforms capable of receiving and processing ADS-C data (in order to feed the pre-operational mode, simulation mode or shadow mode systems) including the Extended Projected Profile (EPP). These platforms will display the shared (air to ground) trajectory data to controllers on their working positions and/or explore the integration of the shared data into the Flight Data Processing Systems for the enhancement of the ground Trajectory Prediction (TP). A system at Eurocontrol Experimental Centre (EEC) collects ADS-C data (with complete EPP trajectories) for off-line data access and online distribution.

In parallel, other SESAR projects are working to integrate the predicted trajectory with air traffic controllers' support tools. The overall goal is to optimise the aircraft's trajectory and make traffic flows more fluid. "In fine, there will be improved efficiency for airspace users and air navigation service providers," says DIGITS-AU project leader Tom Maier from Airbus ATM Engineering.

2.4.1.2   Outcome of the VLD Open 1 call projects (Call H2020-SESAR-2016-2)

The VLD project **AAL2** 'Augmented approaches to land 2' focuses on increased access to airports for low visibility mixed fleet operations. It builds upon the results from the former award winning SESAR 1 project AAL, and will demonstrate augmented approach and landing operations based on the solutions:

- GBAS (Ground Based Augmentation System) CAT II with CAT I airborne and ground equipment, enabling lower decision heights to CAT II minima (DH 100ft) (addresses hubs and medium size airports);

- EFVS (Enhanced Flight Vision System) to Land using Head Up /or Mounted Display, with operational credit down to 300 meters RVR in non- CAT II/III airports (addresses medium and small size airports).

Over 150 flight trials in total are targeted comprising revenue flights as well as flight test aircraft. Flights will cover the full scope of airport categories – small/medium/large airports (Antwerp, Le Bourget, Bremen and Périgueux).

In 2019, the project team prepared the GBAS demonstrations by defining the relevant procedures and prepared the ground and airborne systems. Initial demonstration flights using GBAS CAT I took place in 2019, a pre-requisite for the approval of the CAT II approaches by the regulatory authorities.

In the EFVS work package, the project team performed all the tasks required to receive the approval to fly EFVS procedures at Antwerp, Le Bourget and Périgueux airports. Demonstration flights using

regional aircraft (ATR) took place in April 2019 and the first demonstration flights for EFVS equipped business aircraft (Dassault Falcon) took place at Antwerp airport in December 2019.

The VLD project **AUDIO** 'Airspace User supporting demonstrations of Integrated Airport Operations' started in May 2019. It aims at making aircraft movement on the airport surface safer and more efficient by performing an on-board demonstration for Electronic Flight Bag (EFB) applications at Hamburg airport. To achieve this the project will demonstrate the viability of an innovative advanced and connected moving map application. The application provides the cockpit with local airport data such as the on-ground traffic situation and planned taxi routes. Equipped with this additional information, on-board operations are expected to run smoother as crews are aware of the planned ground trajectory and the surrounding complex environment. This also allows them to react more easily to last-minute re-planning of routes once the aircraft is off-block. This should result in a safer sequence, a more reliable targeted take-off time, less complexity for the crew, more efficient taxiing and fewer emissions due to lower fuel consumption.

In 2019, the project team started to prepare the demonstrations by adapting the ground and airborne systems and planning the exercise. A first version of the demonstration plan was delivered in October 2019.

The VLD project **GAINS** has the objectives of validating, through live flying demonstrations, concepts enabled by Global Navigation Satellite System (GNSS) and EGNOS. These included a Surveillance Concept proposing an electronic conspicuity (EC) solution and a Navigation Concept proposing instrument flight procedure elements incorporating advanced PBN features (e.g. RF Legs) to meet GA needs, including both fixed wing and rotorcraft.

The two concepts of operation were developed, a Surveillance Concept proposing an electronic conspicuity (EC) solution and a Navigation Concept proposing instrument flight procedure elements to meet the needs of GA, including both fixed wing and rotorcraft. GAINS' results have demonstrated that improved integration of GA in today's challenging airspace is indeed possible by adapting SESAR solutions to GA's operations. The headline findings were that:

- EC improves traffic situational awareness for both pilots and ground ATS staff.
- RNP to xLS can be flown by a wide range of GA aircraft and pilots with acceptable track-keeping performance.

The project lifted off thanks to the active collaboration of the GA community, regulators, avionics shops and manufacturers. Eight aerodromes participated in the project, seven for the surveillance demonstrations (Dundee, Sywell, Stapleford, Duxford, Brimpton, Manchester-Barton and Blackbushe) and three for the navigation demonstrations (Duxford, Sywell and Cambridge). EASA and UK-CAA also stepped up to make the demonstrations possible, and 245 pilots volunteered to fly!

In total, for the surveillance demonstrations there were 42 pilots in 27 fixed wing and rotary wing aircraft who completed 43 flight hours in the visual circuit testing EC with cockpit displays within a 100% equipped environment. For the navigation demonstrations, a total of 29 pilots in 22 aircraft flew 357 approach operations on eight advanced PBN instrument approach procedures, incorporating a mix of steep approaches and varying diameter RF legs with LPV and ILS final approaches.

Along the way, GAINS also contributed to regulatory changes that now permit GA to fly RF legs using more affordable avionics.

GAINS was awarded 3rd prize in the research and innovation category of the ATM Awards 2019, run by Air Traffic Management magazine.

The VLD project **GRADE** aims at demonstrating, through flight trials, the applicability to General Aviation and Rotorcraft, equipped with non-certified or specific on-board avionics, of the SESAR Solutions #51, #55, #103 and #113. These SESAR Solutions concern: terminal approaches by using LPV procedures (Sol#51 and Sol#103), final approach CAT II/III based on GBAS augmentation (Sol#55), and low level IFR route using PinS procedure for TMA operations (Sol#113).

The GRADE project performed five demonstration exercises, which included about twenty-eight hours of flight time and twenty-one hours of real time simulations with hardware and human in the loop, involving eight test pilots, four ATCOs, several human factors experts and technical experts / engineers. Performed tests highlighted that the solutions under demonstration are feasible for General Aviation aircraft and rotorcraft and acceptable by both ATCOs and pilots, who can achieve the requested tasks efficiently, accurately and timely.

2.4.1.3 Launch of VLD projects under the Wave 2 call (H2020-SESAR-2019-1)

The Wave 2 call for proposals, within the call with reference H2020-SESAR-2019-1[39], was opened in January 2019 and closed in April 2019. The H2020-SESAR-2019-1 call for proposals consisted in two Work Areas dealing respectively with transversal and industrial research activities (Work Area 1) and VLDs (Work Area 2). Work Area 1 is further described under Subsection 2.3.2.

The total budget of the call for Work Area 2 was EUR 20 500 000. The evaluation was completed in July. Three proposals went through the evaluation process successfully for a total value of awarded proposals of EUR 16 679 510, and the evaluation was followed by the grant agreement preparation phase. At the end of 2019, one project has been launched into execution and will deliver its results in the period from 2020 through to 2022: VLD02 W2 Airport Surface Management, Airport Safety Nets and ATSAW. The project intends to demonstrate the use of the specific avionics (validated within the Wave 1) providing traffic alerts for pilot during runway operations to prevent runway incursion and aircraft collision. The demonstration will address both Mainline and Business aviation solutions during the lifecycle of the demonstration project, the systems will go through a full certification review process to ensure compliance with the applicable certification specification and be ready for deployment.

Two other projects were still in the H2020 grant preparation phase at the end of 2019. Subject to the completion of the grant preparation and signature of the grant agreements, the two projects would be:

- VLD01 W2 GBAS/SBAS precision approaches including variable approach paths: the VLD should demonstrate a number of GBAS/SBAS-enabled advanced approach procedures developed and validated in Wave 1 such as dual thresholds (DT), second runway aiming point (SRAP), increased glide slope (IGS), adaptive increased glide slope (A-IGS) and increased glide slope to a second runway aiming point (IGS-to-SRAP).

- VLD03 W2 Improving runway throughput in one airport: the project should demonstrate a range of Wave 1 solutions improving the runway throughput. The demonstrations should

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[39] Call conditions were set in in the 2019 work programme section of the SESAR JU's Single Programming Document 2019-2021. Call documentation is available on the Funding and Tenders Portal

mainly cover live operations applying optimised wake separation minima (applying Pairwise Wake Turbulence re-categorization concept and using Time based Separation), a reduction of the minimum radar separation distance on final approach and an integrated AMAN/DMAN/Runway Sequencer presenting a holistic view of the arrival and departure sequences.

2.4.1.4 VLD Open 2 call preparation (H2020-SESAR-2020-1)

The VLD Open 2 call for proposals, with reference H2020-SESAR-2020-1[40], was defined using the priorities set out in the European ATM Master Plan and in particular the Essential Operational Changes. It also considers with the operational and technical Measures that need to be implemented in the very short term (2020 to 2025) as outlined in the Architecture Study Transition Plan. The Open call is planned to be open end of January 2020 with a call deadline set end of April. Following the evaluation process, the awarded grant will have to be signed by December 2020 and the projects will deliver their results in the period from 2021 through to 2022. The total budget of the call is EUR 19 551 361.

The call content is structured in a number of topics:

- Optimised use of Airspace: considering traffic hotspots identified in the Airspace Architecture Study Transition Plan, the VLDs should aim at demonstrating an optimised and coordinated organisation of airspace activations and reservations, able to support optimised traffic flows in a free route environment as well as other uses of airspace (e.g. military).

  The demonstration activities may consider scope such as Initial dynamic airspace configuration and application of A-FUA and ATFCM, show case of initial strategies to delegate air traffic services amongst ATSUs and capacity-on-demand arrangements and gradual transition towards higher levels of automation.

- Integrated trajectory Management: the VLDs should aim to demonstrate, in a consolidated and integrated manner, the real time synchronisation of trajectory information between all involved stakeholders.

  The demonstration activities may consider scope such as Free routing operations in cross-border environments; Automated support for adapting the capacity with evolving demand; Cross-border interoperability of mission trajectory elements; Enhanced integration of AU trajectory definition and network management processes, Enhanced Network Traffic Prediction and shared complexity representation; ATM data service provision; Air-ground and ground-ground connectivity.

- U-space capabilities and services to enable Urban Air Mobility: Urban Air Mobility (UAM) refers to the provision of mobility services in an urban environment using air vehicles. These vehicles encompass everything from manned helicopters, as currently flown, through small inspection and delivery drones to 'flying taxis', with or without a pilot. As this important and growing domain evolves, it is clear that new operational concepts, regulations and standards will be needed, underpinned by existing and new technologies. The whole environment will need to integrate safely with manned aviation and air traffic control.

- Environmental sustainability: the VLDs should aim at demonstrating ATM operations mitigating aviation's environmental footprint and significantly contributing to the reduction CO_2 emissions. Applicants are invited to promote and demonstrate "zero CO_2 waste" trajectories.

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[40] Call conditions were set in in the 2019 work programme section of the SESAR JU's Single Programming Document 2019-2021. Call documentation is available on the Funding and Tenders Portal

Projects are encouraged to explore the possibilities for protecting green flights from unnecessary deviations or constraints.

2.4.2 Activities under other financial frameworks

2.4.2.1 Outcome of the Geo-fencing call (SESAR-2017-1)

As set forth in the SESAR JU's Single Programming Document 2017-2019, the SESAR JU has been requested by the EC DG MOVE to organise a call for proposals on Active Geofencing Service.

This call scope focused solely on Active Geofencing Service and it was targeting demonstrations of web-based geofencing solutions that use location signals to prevent drones from flying in no-fly zones. No-fly zones can be generated, monitored and controlled by the authorities responsible.

In response to this delegation agreement, and following a call for proposal procedure, the SESAR JU signed a grant agreement with a consortium coordinated by Thales Avionics SAS on 23 July 2018 for a period of implementation of 15 months, until 23 October 2019, under one project called GEOSAFE.

The GEOSAFE project is a study of the geofencing capabilities of the European drone industry. A geofence is a virtual fence intended to restrict drone flights and has been highlighted as a critical enabling technology for U-space. Many drones and drone service providers within Europe have geofencing capabilities and services. However, manufacturers have not implemented these capabilities in a standardised and coordinated manner. Therefore, GEOSAFE is a first of its kind study aimed at understanding the existing capabilities of geofencing solutions by applying a common framework of testing.

To do this, the project has performed a series of flight trials studying a number of commercially available representative geofencing solutions, including those already proposed by the leaders (DJI, Airmap) and assessed their behaviour in different geofencing situations with regards to various U-space level services as described in the U-space concept of operations (referred to as 'CORUS Conops' as explained in point 2.2.1 above).

In 2019, the project consortium performed 290 flight tests using 16 of the commonly used drones over test sites in three different countries. They investigated geofencing in all different phases of flight where geofences could update during flight planning and execution. Among the topics studied were the different mechanisms for alerting drone pilots to geofences and automatic mechanisms on board drones for restricting flight paths and progress. The definition of no-fly zones, airspace boundaries, restricted areas (both in 2D and 3D) and the stopping and turning abilities of drone were all furthermore studied.

The project successfully demonstrated the three tiers of geofencing, as outlined under EU-wide rules adopted by the European Commission earlier this year. As part of these rules, EU Member States can define designated no-fly zones where drones are not allowed to enter, including airports, airfields, and city centres. GEOSAFE tested three levels as part of its research into development and testing of foundational and advanced geofencing services. The pre-tactical level is a core competency set forth in U1; tactical is a competency aligned with U2; and dynamic is an advanced competency required by U3.

The conclusions were that for U1 - pre-tactical geofencing (Alert/blocking during flight/Alert-Blocking during flight preparation/Restricted area information), the technology is ready and mainly deployed. Approximately 75 % of tested solutions are almost compliant with U1. To achieve full compliance, some standardisation of zone definition, altitude/height reference, fixed/temporary restricted are still needed. For U2 – tactical geofencing (Alert/blocking during flight), the technology is ready but not deployed yet. One drone tested is almost compliant with U2. It was highlighted that since not studied

by the pilot before the flight, information regarding the tactical geofencing provided during flight should be clear and unambiguous. For U3 – Dynamic geofencing (Restricted area updating during the flight), the technology is considered mature but not deployed yet. No tested drones were compliant. Dynamic geofencing requires both standard geofencing capabilities and the capacity to maintain a data link between the UAS and the UTM service provider during flight.

The GEOSAFE project complements the SESAR portfolio of projects related to U-space that encompasses a total of 19 projects in 2019. It was critical to integrate all these projects together in order to ensure an efficient contribution to the development of U-space.

In addition the SESAR JU, supported by Eurocontrol as a U-space Content Integrator in the context of the 'EU Demonstrators Network' led by the European Commission, has promoted and facilitated close cooperation between the U-space projects on one side, and regulation and standardisation bodies such as the EASA and EUROCAE on the other side. Especially, GEOSAFE findings were gradually shared with specific EUROCAE working groups.

The GEOSAFE project has worked on an accelerated schedule, designing its systems, planning and conducting its flight test campaigns and providing its finding in 2019. At the end of 2019, the SESAR JU reviewed and approved these findings (demonstration report). In brief, the GEOSAFE project gathered a large amount of highly valuable information and has made it available to public bodies, authorities and the industry as a whole. The project outcomes and recommendations are already influencing standardisation and regulation. The project information has also shown industry where existing geofencing solutions need to be updated and aligned. The project recommendations will additionally influence the design of geofencing systems for tomorrow and technological improvements for automated drones.

The project completed its activities in November 2019 and on 21 October 2019 it went successfully through a formal final project review by the SESAR JU.

In 2019, the SESAR JU carried out the following communication activities in relation with the entrusted task:

- the creation of a dedicated [webpage](#),
- the announcement of [project launch](#),
- news on [results](#),
- Promotion on social media:
    - https://twitter.com/SESAR_JU/status/1185117775603392512,
    - https://twitter.com/SESAR_JU/status/1141001442330841089,
    - https://twitter.com/SESAR_JU/status/1133697237823959043.

2.4.2.2 Status of the U-space call (CEF-SESAR-2018-1)

In December 2017, the SESAR JU was mandated by the European Commission to perform U-space demonstration activities under the Connecting Europe Facility (CEF) programme, related to the performance of a number of large-scale demonstrations to validate systems that support U-space services against the relevant requirements and standards.

The objective of this initiative is the execution of a number of large scale demonstrations for the U-space services that support the management of drone operations in the context of growing autonomy of drones and growing traffic density. The U-space services may include: flight planning, flight approval,

safe and robust navigation and dynamic geo-fencing enabled by EGNOS and Galileo, tracking, airspace dynamic information, and dynamic interfaces with air traffic control, as outlined in the U-space Blueprint. This call will complement ongoing U-space activities, speed up U-space deployment and stimulate close cooperation with EASA, standardisation bodies and industry including newly emerging stakeholders.

2.4.2.2.1 Operational implementation of the entrusted task

In 2019, six projects were in execution following the conclusions of the call for proposals with reference CEF-SESAR-2018-1.

The projects under this implementation action aim to demonstrate initial versions of U-space services through the early demonstration of U-space systems and procedures. The work complemented more conceptual SESAR exploratory research U-space projects with real world flight trials. The aims were twofold. First, to utilise commercial off-the-shelf and near-term technologies to investigate state-of-the-art but achievable U-space service solutions in tightly controlled experimental scenarios. The second aim was to take the outcomes from these experiments and use the valuable real word tested information to make conclusions on maturity recommendations on initial achievable standardisation and to understand how the U-space framework as defined by the CORUS project (Concept of Operation for EuRopean UTM Systems)[41] refined, improved and progressed.

As shown in the figure below, these six projects complement the SESAR portfolio of projects related to U-space that encompasses a total of 19 projects in 2019. It was critical to integrate all these projects together in order to ensure an efficient contribution to the development of U-space.
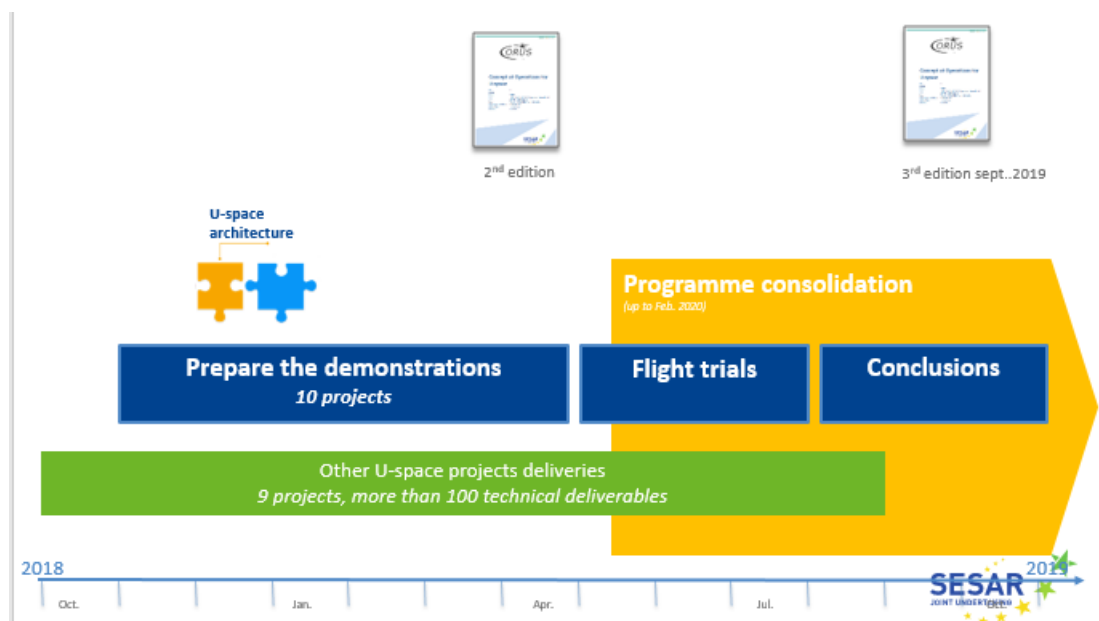
Figure 13: Integration of the six U-space projects under CEF into the SESAR U-space framework

At the start of 2019, the SESAR JU has set up a programme management framework tailored to these projects including management and technical aspects, with the aim to collect and consolidate the outcomes of the various projects at programme level. Under this programme management framework,

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[41] The CORUS project is conducted under SESAR JU supervision through another framework.

all U-space projects have to produce their reports in compliance with a specific SESAR JU guidance with the aim of delivering conclusions and recommendations that fit with the SESAR JU's expectations.

Figure 14: The SESAR programme management framework as applicable to U-space projects

Furthermore, to encourage close cooperation with several bodies and institutions, the SESAR JU is supported by Eurocontrol as a U-space Content Integrator in the context of the 'EU Demonstrators Network' led by the European Commission.

In that framework, in 2019, the SESAR JU has called four workshops with all the 19 SESAR U-space projects (under CEF and other funding programmes) to ensure a common approach (i.e. all the projects use the same templates to feed the SESAR JU with similar information and details), solve common technical issues and boost the projects. The six U-space CEF projects were key players in this development as they brought together a wide range of industry and stakeholders including drone operators, drone service providers, technology providers (hardware & software), emergency services, public representatives and authorities.

In addition, the SESAR JU has promoted and facilitated close cooperation between the projects and regulation & standardisation bodies such as the EASA and the EUROCAE.

The following paragraphs present the progress and specific developments of each project.

DIODE (D-flight internet of drones environment)

Understanding the risk, safety and human performance impact of every part a U-space solution was central to demonstration work performed by the DIODE project. The project demonstrated U-space services through six contemporary missions with "unmanned" and "manned" flights in several geographical situations including urban area and close to a small airport. The project developed an approach around ensuring the required level of safety for all airspace users and people on the ground, while multiple drone operators conducted drone operations, each one pursuing its own business or recreational objectives, in all environments and included a wide range of operational scenarios: parcel delivery; road traffic patrol; professional photography; railway and power lines surveillance; search and rescue, airport operations; interaction with general aviation; and firefighting. This involved classifying airspace and restricting drone missions using a risk based approach. The DIODE solution is

based on two pillars to manage the complexity of multiple operations in same volume of airspace and in an Aerodrome Traffic Zone:

- On drone capabilities, which can apply containment measures in order to ensure to stay in the authorised volume of airspace;

- U-space services, which allow spacing among all drone operations in strategic manner (i.e. planning and strategic deconfliction) and monitoring of compliance of drone operation with authorised volume (tracking and monitoring). Moreover, it is possible to inform/alert in case of contingency/emergency situations the involved actors (tactical geofencing, emergency management, collaborative interface with ATC).

In controlling strictly for risk and safety DIODE demonstrated that a limited set of services are achievable in the near-term in certain conditions. The level of efficiency, safety and security of the services offered by the DIODE solution was met positively by drone operators and public authorities.

DOMUS (Demonstration of Multiple U-space Suppliers)

DOMUS, is a demonstration project that aims to prepare and de-risk a rapid deployment of U-space initial services (U1 and U2) and some specific U3 services thorough live demonstration trials in different environments for Very Low Level operations. In particular DOMUS chose to support multiple U-space service providers through hybrid federated/centralised architecture approach. Based on lessons learned from the world of air traffic management, the project chose to centralise services that are critical for maintaining the safety of the system in an eco-system manager. Multiple U-space service providers were then facilitated by allow the (USPs) to build their own packages of value-added services on top of safety critical elements managed by the eco-system manager. The project performed flight test campaigns at two flight test centres and one urban environment in Spain. The project investigated a wide range of scenarios and developed the services to support them. The scenarios included multiple types of drone-drone interactions, drone-General Aviation interaction, emergency situations all executed while maintaining a common air picture with air traffic management system. The project also included an urban scenario where drones were integrated as mobile sensor platforms in a smart city IOT concept. The project showcased a collaboration and a shared vision of U-space between a wide-number of Spanish industrial partners both well-established new entrants.

SAFIR (Safe and flexible integration of Initial U-space services in a real environment)

Core to the SAFIR project was the idea of interoperability. The project showed that through information sharing different U-space service providers could provide services independently to drone operators and also collaborate collectively to manage shared airspace safely together. The project achieved the technically very challenging undertaking of making what is known to one service providers system available to another service provider's system. To do so involved the clear agreement on the definition U-space services between multiple and showcased how likely competitors could collaborate. SAFIR conducted two main demonstrations. The first was at the dedicated drone testing facility DronePort, a partner on the project. The DronePort demonstration was attended by the European Commissioner for Transport Ms. Violeta Bulc, who congratulated the project on its achievements. The second demonstration involved achieving U-space service provision in complex real world working environment of Port of Antwerp. The demonstration involved 13 partners, manned and unmanned flights and unique use-cases like the monitoring of shipping emissions using drones. The

project concluded that feasibility of multiple interconnected UTM systems exchanging data to allow safe drone operations is feasible, however a standardised a common altitude reference is needed. The project concluded that technology exists to make the widespread use of drones for a variety of applications in a safe manner possible. These conclusions and evidence are being passed on to the various regulation and standardisation bodies.

EuroDRONE (A European UTM testbed for U-space)

The focus of the Eurodrone project is automation and its demonstration activities involved in an automated drone interacting with a highly autonomous U-space services system. The project developed an intelligent transponder processing board intended to be installed on drones enabling on-board automation and having full authority of flight mission planning. The drone then interacted with a highly autonomous cloud based Drone Traffic Management platform over an innovative vehicle to infrastructure link (V2I). The aim was to have the drone and DTM system collaborate in a highly autonomous way to plan and execute drone missions. The automated drones in the trials were required to interact procedurally with air traffic management, with other manually controlled drones and general aircraft. The project additionally looked at prototyping a Detect and Avoid (DAA) service as an enabler for drones to detect cooperative conflicting traffic, or other hazards, and take the appropriate action to comply with the applicable rules of flight. The project has provided the first end-to-end U-space demonstration in South East Europe/Mediterranean Region and also demonstrated with long range BVLOS (50+ km) flight in the Patras area of Greece. The conclusions of the project will help in understanding the initial automation levels possible for U-space service solutions.

VUTURA (Validation of U-space by tests in urban and rural areas)

The strength of the VUTURA project was the diversity of environments and scenarios that U-space services were deployed in. This variety helped challenge and mature the definitions and implementations of U-space services. The VUTURA project involved demonstrations in two urban, one rural and one smart city environment. One complex scenario involved the integration of drone monitoring, package delivery and fire-fighting between a city and its local airport. All demonstrations conducted by the project involved two U-space service providers collaborating and showed how a common U-space framework with U1 and U2 services can enable multiple U-space service providers and multiple operators to execute commercially feasible B-VLOS operations.

GOF-USPACE (Finnish-Estonian "Gulf of Finland" very large U-space demonstration)

GOF-Uspace explored a different kind of information sharing. A pre-operational Flight Information Management Service (FIMS) was designed and implemented, interoperably integrating three different U-space service providers and a ANSPs ATM system. The trials addressed initial integration of drones and manned aviation in the same airspace, cross-border U-space service provision and collaboration with ATC. The approach to interoperability demonstrated by the project is based on SESAR SWIM principles and involves reading and writing to common registries of information and maintaining a single true source of information. The SWIM principles extends how information is shared, stored and managed. The demonstrations performed by the project brought together a broad consortium with 19 members, including three world-leading UTM (Unmanned Traffic Management) technology

vendors, two air navigation services providers collectively and cooperatively manage all drone traffic in the same geographical region. The project featured the first international drone flight with ATC collaboration, observed in both ATM and UTM. The project also demonstrated the first SESAR air taxi. In the trial, an air mobility taxi was fully connected with ATC and two U-space service providers working in the same geographical area. That the taxi flight plan was accepted by ANSP and FIMS shows acceptance in the Altitude Angel, AirMap and Unifly UTM systems.

All projects will deliver their final study reports and related technical appendices by the end of February 2020 and will be closed by the end of March 2020.

2.4.2.2.2   Communication activities

In 2019, the SESAR JU raised the visibility of the U-space demonstrations through a range of activities and communications channels. These activities aimed to show how the European Union and its industries are making progress with the integration of drones into the airspace in a safe and secure manner. The SESAR JU showcased the activities of the demonstration projects at several events (see also point 2.5.3.1 below):

- **World ATM Congress**, 10-12 March 2019, Madrid: the demonstrations were presented by the SESAR JU and project partners through two dedicated walking tours and a technical session (view video or read article);

- **Aerodays 2019**, 27-30 May 2019: U-space and the demonstration projects were promoted through the SESAR JU's stand and a dedicated session on urban air mobility (read article);

- **Organisation of visit by European Commissioner for Transport to SAFIR demonstration site**, 5 September 2019 (read article);

- **U-space ConOps and Research Dissemination Conference**, 30 September – 1 October 2019, Brussels: the conference brought together 250 participants to discuss the initial outcomes of the demonstration projects. The conference included an exhibition at which all projects could present their work in more detail (read article).

Other events at which U-space demonstrations were promoted included: Qatar CAA-SESAR JU workshop (March 2019), Paris International Airshow (June 2019), ICAO Drone Enable conference (November 2019), the EASA high level conference on drones (dedicated panel - December 2019).

The SESAR JU published 25 news items relating to U-space and the results coming out of the demonstration projects. Furthermore, arranging media opportunities to promote U-space and the work of the demonstrations resulted in articles in the media, for instance in International Airport Review in June 2019.

Promotion of U-space demonstration projects can be found at the SESAR JU's webpages: https://sesarju.eu/U-space and the coverage of U-space was also presented on Twitter and LinkedIn (see examples):

- https://twitter.com/SESAR_JU/status/1181224224838574080,

- https://twitter.com/SESAR_JU/status/1169601297953284097,

- https://twitter.com/SESAR_JU/status/1171444756196417538,

- https://twitter.com/SESAR_JU/status/1194662641987391488.

2.5   Strategic Area of Operation 5: Deliver SESAR Outreach

The SESAR JU met all its objectives related to SESAR Outreach in 2019. This includes the following achievements and results:

- *Strengthen the global interoperability activities aligned with European Commission expectations, especially towards the ICAO in close collaboration with the FAA/NextGen and other global modernisation initiatives: the SESAR JU prepared and supported the EC and ECAC positions during the 40th Assembly of the ICAO, resulting in the sixth edition of the ICAO GANP; cooperation with the US FAA continued and cooperation with other regions (e.g. Georgia, Japan, Qatar, Singapore) was strengthened (see Subsection 2.5.1)*
- *Strengthen links towards Standard Making Organisations like EUROCAE, RTCA etc. with the involvement of SESAR members and the availability of SESAR material in support of standardisation: cooperation continued with EUROCAE, EASCG and the EUSCG (see Subsection 2.5.2.7)*
- *Strengthen communication of SESAR Solutions/demonstrations/ER activities and results through SESAR publications, workshops and events: the SESAR JU participated at major events on ATM worldwide and made six major publications on top of the regular project reporting (including 11 ER final project reports) (see Subsection 2.5.3)*
- *Active cooperative arrangement with all European (Member States and Regions) actors, international actors and other modernisation initiatives in aviation relating to SESAR Definition and Development phases: cooperation continued with major actors and international initiatives related to SESAR (see Subsection 2.5.2)*
- *Prepare new cooperative arrangement with European (Member States and Regions) actors, international actors and other modernisation initiatives in aviation relating to SESAR Definition and Development phases: a new cooperative arrangement was established with Georgia in September 2019*

In 2019, in continuation of previous years' activities, the SESAR JU succeeded in promoting European approaches in international fora and secured Europe's leadership in the evolution of ATM globally, notably at ICAO level. This was achieved in close collaboration with all European institutional partners and stakeholders, as well as key international partners.

The SESAR JU is responsible for securing the support and buy-in of all stakeholders in the ATM value chain for the definition and development of SESAR technologies and procedures (SESAR Solutions). This requires continued and extensive outreach (communications activities and external relations) targeting a wide range of organisations, including ANSPs, airspace users, airports, the manufacturing industry, national aviation authorities and the EASA; standards-setting organisations; professional staff organisations; as well as the relevant scientific institutions or the relevant scientific community. The following figure shows the broad range of stakeholders with whom the SESAR JU interacts at various levels in relation to the SESAR project Definition, Development and Deployment phases and to global air traffic management matters at large.

Founding Members

Figure 15: The SESAR JU's specific stakeholder groups within the ATM value chain

These outreach activities are supported by the core SESAR JU membership, as well as cooperation agreements and contracts with specific stakeholder groups. The SESAR JU also conducts outreach activities with international partners in support of global interoperability and harmonisation, recognising these as vital prerequisites for a safe, secure, efficient and sustainable global ATM system.

During 2019, the SESAR JU continued its outreach activities with external stakeholders under a range of cooperative arrangements as described in the sections below. This collaboration is crucial to the success of the SESAR JU's work and a major contributor to the SESAR JU deliverables.

2.5.1   International cooperation

With reference to its strategy for cooperation with third countries and/or international organisations, the SESAR JU continued to engage during 2019 in international activities in the framework of the EU Aviation Strategy and in close coordination with the European Commission. The principal objectives were to secure SESAR's position as a global leader in ATM modernisation in support of the ICAO's Global Air Navigation Plan (GANP), to support EU industrial leadership and to promote SESAR Solutions for global interoperability and harmonisation.

A key milestone in 2019 was the 40th ICAO Assembly in September/October. The SESAR JU participated actively with the EC and ECAC states and European organisations, to prepare Europe's working papers and positions for the Assembly. The collaboration followed a common European line to take ensuring that the European ATM Master Plan, the European Aviation Safety Plan and the SESAR ATM modernisation programme maintained a leading role in the evolution of the ICAO Global Air Navigation

Plan (GANP)/Aviation System Block Upgrades (ASBUs) and the Global Aviation Safety Plan. In particular, the 40th ICAO Assembly endorsed the sixth edition of the ICAO GANP.

The SESAR JU maintained its close cooperation, both formally and informally, with the FAA and its NextGen programme, under the revised EU-U.S. Memorandum of Cooperation (MoC) on Air Traffic Management Modernisation, Civil Aviation Research and Development, and Global Interoperability, signed in December 2017. Under Annex 1 Appendix 1 of the MoC dealing with SESAR/NextGen collaboration on R&D, the SESAR JU led the work on the European side aimed at ensuring harmonisation and interoperability between the two programmes where appropriate. Two Coordination Committee (CCOM) meetings were held in 2019 leading in particular to the preparation of a 3-year work programme to 2021. This was submitted for approval to the MoC Executive Committee co-chaired by the European Commission and the FAA.

Efforts also continued during the year to build closer cooperation with other international partners. In 2019 the SESAR JU developed activities with a number of international partners with whom cooperative arrangements were already in place. A SESAR workshop was held in Doha, Qatar in March 2019 under the MoC between the SESAR JU and the Qatar CAA. This workshop focused on two topics: remote towers and the integration of drones. Discussions also intensified under the MoC between the SESAR JU and CAA Singapore aimed at developing a joint future ATM vision, with the aim of publishing a joint document in the first half of 2020. A new cooperative arrangement was established between the SESAR JU and the Georgian CAA, with a Letter of Intent being signed during the ICAO Assembly in September 2019 with a view to exploring opportunities to share information and expertise on topics of mutual interest, including through the organisation of dedicated meetings and events such as workshops.

The SESAR JU also participated in a number of international activities during 2019. This included the iCNS Conference in Washington DC in April, and the EIWAC Conference in Tokyo, Japan in November. The SESAR JU also supported EU technical cooperation projects being managed by the EASA, in particular participating in a workshop in Singapore on ATM master planning for the ASEAN countries.

2.5.2   Stakeholder engagement

2.5.2.1   European Union Aviation Safety Agency

The cooperation and coordination between the EASA and the SESAR JU under the MoC signed in 2016 was furthered strengthened in 2019. Results of this excellent cooperation were made visible with the delivery of the European ATM Master Plan and Airspace Architecture Study including a more direct and explicit link with the updated European Aviation Safety Plan (EPAS).

The cooperation was also focused in 2019 on drone/U-space activities to support EASA rulemaking development.

In order to further deepen the cooperation at technical levels, the EASA and the SESAR JU agreed to explore the feasibility of implementing an inter-institutional service-level agreement (SLA) between the two agencies for potential implementation in 2020.

2.5.2.2   European Defence Agency

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.

The SESAR JU and the European Defence Agency (EDA) have been engaged in close dialogue since 2011 and this relationship continued in 2019 to deepen on military matters and opinions into the Programme. EDA now serves as the main interface between SESAR 2020 and SESAR JU activities and military aviation and ATM and sets the responsibilities for EDA to facilitate the coordination of military views with regard to Single European Sky and SESAR.

The cooperation under the MoC in 2019 focused on securing military inputs into the update of the European ATM Master Plan as well as technical advice to project evaluations and the programme in general.

2.5.2.3 SESAR Deployment Manager (SDM)

During 2019, the collaboration under the 2015 Memorandum of Understanding (MoU) between the SESAR JU and SDM continued with regular meetings. Of particular interest during 2019 were the coordination around the delivery of the Master Plan update and the Airspace Architecture Study.

2.5.2.4 Standards-making organisations

The collaboration between the SESAR JU and the standard-making organisations is part of the mitigation of risks recognised in the coordination of the ATM Master Plan.

2.5.2.4.1 EUROCAE

The SESAR JU continued to ensure 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.

During 2019, SESAR deliverables were made available in support of standardisation development work in several EUROCAE Working Groups covering several key content areas of the SESAR 2020 work as well as towards the coordination with the equivalent Special Committees of RTCA.

EUROCAE published standards in 2019 with contributions from and of direct relevance to SESAR Solutions.

2.5.2.4.2 The European Air Traffic Management Standards Coordination Group (EASCG)

In 2019, the SESAR JU 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 is used as a major input in 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 of both the process and contents into the ICAO standardisation roadmap development.

2.5.2.4.3 The European UAS Standards Coordination Group (EUSCG)

In 2019, the SESAR JU continued as an active participant in the European UAS Standards Coordination Group (EASCG), with the objective to coordinate UAS related standardisation activities and needs.

2.5.2.5 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 four framework contracts and related specific contracts reflecting the specific interests and skills of different categories of airspace users (Lot 1 European scheduled airlines; Lot 2 Global airlines, Lot 3 Business aviation and Lot 4 General aviation and rotorcraft). Their expertise is recognised as key in ensuring the overall success of SESAR 2020 activities.

In 2019 the airspace users supported the SESAR JU in the monitoring and steering of SESAR 2020 projects, providing substantial expertise into reviewing and commenting the Solution projects' deliverables through delivery of technical analyses, priority and gap analyses, participation in maturity gate meetings and validation exercises, and provision of technical advices. This was key for a robust assessment of the quality of SESAR Solutions and the benefits expected from their implementation. Airspace user support to the programme was particularly intense in 2019 as this was the last year of Wave 1 of SESAR 2020, where all Solution projects intensified their effort – and therefore sought more support – to deliver in accordance with their grant agreements and the programme's expectations.

Beyond this support to the programme activities, their input was also crucial to provide airspace user communities' views, concerns and requirements on the Master Plan update through membership in the Master Planning Committee and Master Planning Group and active participation in the formal consultation phase of the adoption process.

Airspace Users were also consulted during the process of development of the Airspace Architecture Study Transition Plan, through specific and targeted multilateral or bilateral meetings as well as membership in the "AAS-Transition Plan Team", which supported the SESAR JU between May and July 2019 for the preparation of the document.

2.5.2.6 Professional staff organisations

The SESAR JU collaborated in 2019 under a new framework contract, governing new specific contracts, with the following professional staff organisations (PSOs): the International Federation of Air Traffic Controllers' Associations (IFATCA); the European Cockpit Association (ECA); the International Federation of Air Traffic Safety Electronics Associations (IFATSEA); the European Transport Workers' Federation (ETF); and the Air Traffic Controllers European Union Coordination (ATCEUC).

The integration of PSO expertise and direct support to the SESAR JU, and thereby the SESAR 2020 programme, continued with pool of a large number of licensed and operational controllers, pilots and engineers of all nationalities providing relevant and cross-border operational and technical knowledge of direct relevance to the successful deliveries of SESAR results and solutions.

In 2019, four quarterly coordination meetings were held to coordinate activities, with priorities defined in a work programme agreed between the SESAR JU and the PSOs in relation to ATM modernisation. The PSOs provided strategic input to both the Master-Plan campaign and the Airspace Architecture Study (see above Subsections 2.1.2 and 2.1.1 respectively), as well as direct support to specific research programmes and external events. Of particular note was the detailed participation of the PSOs in the complex multiple remote tower research, which has been of particular concern to the PSOs. This fruitful cooperation has been of immense value to both the PSOs and the SESAR programme, and is the model for future PSO involvement.

2.5.2.7 Airports Council International Europe

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

In 2019, the close cooperation between ACI EUROPE and the SESAR JU continued allowing an efficient and constructive relationship, materialised by a new specific contract implementing the framework contract established in 2016. Through this contract, the following main activities were performed:

- ACI EUROPE and the SESAR JU co-organised the first Digital Sky Challenge, a 48-hour innovation sprint in which 12 competing teams from across Europe were asked to come up with solutions addressing safety, the environment and a better passenger experience. Hosted by Athens International Airport, the data-driven event involved 23 other partners. ACI EUROPE led the project, initiated and sponsored by the SESAR JU. In this role, ACI EUROPE planned, executed and communicated on the Digital Sky Challenge, in close coordination with the SESAR JU and the other stakeholders involved. See Subsection 2.5.3 Communications for further details;

- ACI EUROPE supported the SESAR JU in communication activities by publishing several SESAR related news items and an article in ACI EUROPE's newsletters and magazine;

- The SESAR JU promoted the work performed in SESAR and explained the benefits for airports at the main ACI EUROPE events: the Regional Airports' Conference and Exhibition in Krakow, Airport Exchange in Abu Dhabi and the Technical, Operations and Safety Committee bi-annual meetings in Malta and Copenhagen;

- After a professional proof-read, ACI EUROPE printed and delivered to the SESAR JU 500 copies of the publication titled 'SESAR and the digital transformation of Europe's airports', initially published at the end of 2018 with the support of the SESAR JU;

- The SESAR JU plans to organise a breakfast meeting on the role of research and innovation in supporting regional connectivity and sustainability in 2020. ACI EUROPE supported the SESAR JU in the preparation of this event. In particular, ACI EUROPE worked closely with the SESAR JU by helping in the definition of the event topic, identifying host and participating Members of the European Parliament, defining the programme and initiating the event organisation from the logistics perspective;

ACI EUROPE experts participated in several SESAR 2020 project events (i.e. validation open days and final dissemination events) on behalf of the SESAR JU, providing an airport experts' view on these activities to the SESAR JU.

2.5.2.8 National Authorities

In 2019, the SESAR JU continued the cooperation arrangements with National Supervisory Authorities (NSAs). The main objective of the cooperation with NSAs is to secure their early involvement in the definition and development activities to minimise the risks inherent to the transition between SESAR development and deployment activities. Sixteen national Authorities participate in the cooperation with the SESAR JU under bilateral MoCs. The SESAR JU and national authorities met on a quarterly basis and progressed according to an agreed work plan following up the work and discussing and detailing the main activities. In addition to the quarterly meetings with all NSAs, the SESAR JU conducted bilateral meetings with NSAs at national level to provide an update on SESAR and strengthen the cooperation.

The main areas of interest for NSAs were the update of the European ATM Master Plan, the Airspace Architecture Study, demonstration activities as well as U-space.

2.5.2.9   Space

2.5.2.9.1   European Space Agency

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.

Within the context of a Memorandum of Cooperation (MoC) signed between the ESA and the SESAR JU in 2016, coordination between the two organisations has progressed well, particularly in relation to ESA/Inmarsat Iris activities and the SESAR JU PJ.14 project on satellite communications. This activity allowed the development of a shared view on the value chain and interdependencies between both Programmes. Ultimately, this coordination with ESA and the finalisation the Iris system are key to enabling 4D operations worldwide.

2.5.2.9.2   European GNSS Agency (GSA)

Informal coordination with GSA continued during 2019. This included in-depth coordination in the context of the update of the European ATM Master Plan, in particular to highlight the role of EGNOS and Galileo in the future multi-frequency, multi-constellation GNSS system.

2.5.2.10   Clean Sky 2 JU

In 2019, the cooperative arrangements with the Clean Sky 2 Joint Undertaking (the Clean SKY 2 JU)[42] continued under the MoC signed in December 2015. The cooperation in 2019 focused on identifying synergies and complementarities in the respective programmes.

2.5.3   Communications

2.5.3.1   Events and conferences in 2019

Over the course of 2019, 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 close to 120 further events, raising the visibility about SESAR.

World ATM Congress, 12-14 March 2019, Madrid

"Europe for Aviation" was the theme around which the SESAR JU and other European aviation organisations working to implement the Single European Sky gathered at the World ATM Congress, from 12 to 14 March in Madrid, Spain. The "Europe for Aviation" stand and theatre hosted a wide range of debates, presentations and guided walking tours, illustrating the collaboration in action between European aviation organisations working to implement SES, namely the European Commission, Eurocontrol, SESAR JU, SESAR DM, EASA, EDA, Innovation and Networks Executive Agency (INEA), and EUROCAE. In doing so, the organisations demonstrated how between them they cover the full project management cycle from policy and funding to research and deployment.

The SESAR JU in collaboration with the SESAR Deployment Manager organised 16 walking tours giving visitors an opportunity to meet with experts from the SESAR community and see at firsthand the wide variety of solutions that are being delivered and deployed across Europe.

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[42] Council Regulation (EU) No 558/2014 of 6 May 2014 establishing the Clean Sky 2 Joint Undertaking (OJ L 169, 7.6.2014, p. 77–107)

Aerodays, 27-30 May, Bucharest

SESAR research was the focus of debates, sessions and a dedicated stand at AEROdays, the eighth edition of European Aeronautics Days, a flagship event of the European Commission. Organised under the EU Romanian Presidency, the conference and exhibition welcomed over 800 researchers and representatives from the aviation and aerospace industry to hear about the results from Horizon 2020 projects.

In his keynote, Florian Guillermet, Executive Director of the SESAR JU, reminded the audience of the need to keep the focus on the passenger when researching and developing new solutions in aviation and ATM. SESAR experts presented a number of innovations in the pipeline to transform ATM, in a series of sessions addressing airport operations, air traffic services, network operations, the underlying infrastructure and drones. The SESAR JU also welcomed conference visitors to its stand in order to discover more about the results of the programme so far.

Paris Air Lab/Paris Air Show, 17-23 June, Paris

The SESAR JU showcased the results of its research and innovation programme at the International Paris Air Show at Le Bourget. At a stand in the Paris Air Lab - a space dedicated to innovation and prospective in the aerospace industry - visitors had an opportunity to meet representatives from the SESAR JU and experts in the fields of airports, air traffic service provision, enabling technologies and drones to discuss all aspects of the SESAR research and the results delivered so far.

The SESAR JU welcomed many high level visitors, including then European Commissioner for Transport, Violeta Bulc and European Commission's Director General for Transport and Mobility, Henrik Hololei, who also had a chance to visit many SESAR JU members, including Airbus, Dassault Aviation and Thales, who presented some of the work they are performing within the SESAR JU research programme. The SESAR JU also received delegations, including from DG MOVE, DG GROW, DG Competition, ICAO, EDA and many more throughout the week.

R&I Days, 24-26 September, Brussels

Organised by the European Commission, the event is an annual policy event bringing together decision-makers, industry, finance, academia and business to debate and shape the future research and innovation landscape. The SESAR JU took part in the exhibition on the sidelines of the policy conference, showcasing the results from its EU-funded R&I projects that have an impact on citizens' daily lives. During the 3-day event, the SESAR JU welcomed some high level visitors to the stand, including Jean-Eric Paquet, the European Commission's Director General for Research and Innovation, and Grazia Vittadini, Chief Technology Officer of Airbus.

U-space ConOps and Research Dissemination Conference, 30 September – 1 October, Brussels

The major conference, which was kindly hosted by SESAR JU founding member Eurocontrol, presented the results from SESAR JU's portfolio of U-space exploratory research and demonstration projects to around 250 participants from across the aviation spectrum. The first day of the conference featured a presentation on the U-space concept of operations and the need for a harmonised approach to integrating drones into very low level (airspace in a safe and socially acceptable way. During the second day, sessions tackled the key questions of safety, interoperability and maturity, each animated by projects from the SESAR JU's U-space exploratory research and demonstration activities. Each project

presented the results of their flight trials and tests, then engaged the audience in a lively question and answer session. The projects were also showcased in a dedicated exhibition outside the conference hall.

SESAR Innovation Days, 2-5 December, Athens

Hosted by Greece's National Centre of Scientific Research (NCSR) "Demokritos", this year's SESAR Innovation Days (SIDs) showcased results from European exploratory research on ATM. Main highlights of the event included:

- 38 papers and 21 posters presenting research on a variety of themes, including blockchain technologies for drones, safety net solutions, data-driven predictability tools, detection and tracking technologies for airport surface management, etc;

- panel discussions on automation and international collaboration;

- launch of the SESAR Digital Academy (see also above in Subsection 2.2.4.3), an initiative that the SESAR JU is working on to attract young talent with a skillset matching the needs of the future ATM system;

- the SESAR Young Scientist Award ceremony, featuring presentations from the three short-listed scientists.

More detailed information on the content of the SIDs are available in 2.2.4.1 above.

Digital Sky Challenge, 2-4 December, Athens

The SESAR Innovation Days was a perfect backdrop to organise the Digital Sky Challenge, a 48-hour innovation sprint in which 12 competing teams from across Europe were asked to come up with solutions addressing safety, environment and a better passenger experience. Taking place at Athens Airport, the Challenge aimed to see what could be achieved by harnessing big data and AI technologies for aviation. Co-organised by Athens Airport, ACI Europe and the SESAR JU with 23 other partners, over the two-day the teams developed their solutions from several data sources, which they first pitched to 19 mentors and then to a jury made up of aviation experts. The winners were announced at an awards ceremony held in the Stavros Niarchos Foundation.

In addition, the SESAR JU provided guidance and support to research projects in promoting workshops, open days and conferences related to the SESAR research and innovation programme.

2.5.3.2 Publications

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

SESAR Innovation Pipeline – 2019 Highlights SESAR 2020 is a European research and innovation programme that aims to transform ATM into a more modular, scalable, automated, interoperable system that takes advantage of advances in digital and virtualisation technologies. This brochure provides highlights of some of the SESAR research and development (R&D) activities that took place over the course of 2019, as well as what is coming in 2020. View publication	
A proposal for the future architecture of the European airspace The proposal for the future airspace architecture of the European airspace defines how Europe's airspace architecture should look in the medium- to long-term (2025-2035), and what practical steps would need to be taken to make it a reality. The proposal is for a new approach to Europe's airspace architecture that leverages modern technologies and decouples service provision from local infrastructure. It also sees a progressive increase in the levels of automation, cyber-secure data sharing and connectivity. View publication	
Future architecture of the European airspace – Transition plan The transition plan identifies three key operational and technical measures that need to be implemented in the very short term (2020 to 2025) in order to set in motion the transformation changes outlined in the Airspace Architecture Study. The implementation of these measures is necessary to address the current capacity challenges with short-term actions and to secure the Airspace Architecture Study implementation timeline. View publication	

SESAR Solutions Catalogue – 2019 edition

The third edition of the SESAR Solution Catalogue, provides a holistic view of the status of SESAR R&D in 2019 and offers solutions to some of the pressing challenges facing European aviation today. The publication covers the results of the first R&D programme (SESAR 1); more than 60 solutions, many of which are in the process of deployment at local and European levels. It also presents details of the ongoing R&D (candidate solutions) as we reach midway in the current programme, SESAR 2020. Finally, the catalogue gives a flavour of some of the promising results coming out of SESAR's dedicated exploratory research programme.

View publication

European ATM Master Plan

Updated every 3-4 years through an extensive consultation process involving all industry and institutional stakeholders, the European air traffic management (ATM) Master Plan sets the direction for developing, delivering and deploying the technologies and standards needed to transform Europe's aviation infrastructure enabling it to handle the future growth and diversity of air traffic safely and efficiently, while minimising environmental impact. The plan is also instrumental for ensuring global harmonisation and interoperability, in support of the Global Air Navigation Plan (GANP) of the International Civil Aviation Organization (ICAO). The Plan also reflects the recommendations made by Wise Person's Group as well as a joint declaration by industry on the need to implement a digital European sky.

View publication

Digital European Sky Blueprint

The digital European sky leverages the latest digital technologies to transform Europe's aviation infrastructure enabling it to handle the future growth and diversity of air traffic safely and efficiently, while minimising environmental impact. The brochure outlines the portfolio of research as well as measures needed to deliver the digital European sky.

View publication

2.5.3.3 Press

In 2019, the SESAR JU continued its outreach to trade press and member/partner media channels, with more than 15 featured articles and interviews in a range of magazines and online media:

- the trade or specialised press, including International Airport Review, Airport Business, Air Traffic Management, Horizon, Aerospace Europe, ScienceX,

- the European and international press such as the Parliament Magazine, EurActiv, Horizon Magazine; Euronews, Sole 24 ore, RAI Cultura, CORDIS,

- member/partner media (Eurocontrol's Skyways, ERA, ECAC, Skyguide, DSNA, NATS).

A dedicated space highlighting some of the press coverage from 2019: https://sesarju.eu/newsroom/press-coverage

2.5.3.4 Online communication

2.5.3.4.1 Website and e-news

The SESAR JU website was updated to give greater visibility to the results and deliverables of SESAR 2020 projects, including an interactive map featuring 'success stories'; SESAR Digital Academy; artificial intelligence; international cooperation; Digital Sky Challenge. In 2019, the SESAR JU maintained its online readership with an average of 45 000 visitors to its public website on a quarterly basis (a 10% increase). Many visitors were new, which may be attributed to the increased visibility of U-space R&D.

A monthly e-news was sent to external audiences (over 4.000 contacts, all GDPR compliant), as well as over 30 dedicated event mailshots and press releases attracting further traffic to the SESAR JU website. Among the most popular items are the U-space and drone developments, projects, news and vacancy notices.

2.5.3.4.2 Social media

In 2019, SESAR JU social media communication achieved positive results in the majority of its KPIs, such as the growth rate, SESAR JU own activity, engagement. The SESAR JU published 1 039 posts, retweets, shares, comments on social media compared to 883 in 2018, representing a 17% increase.
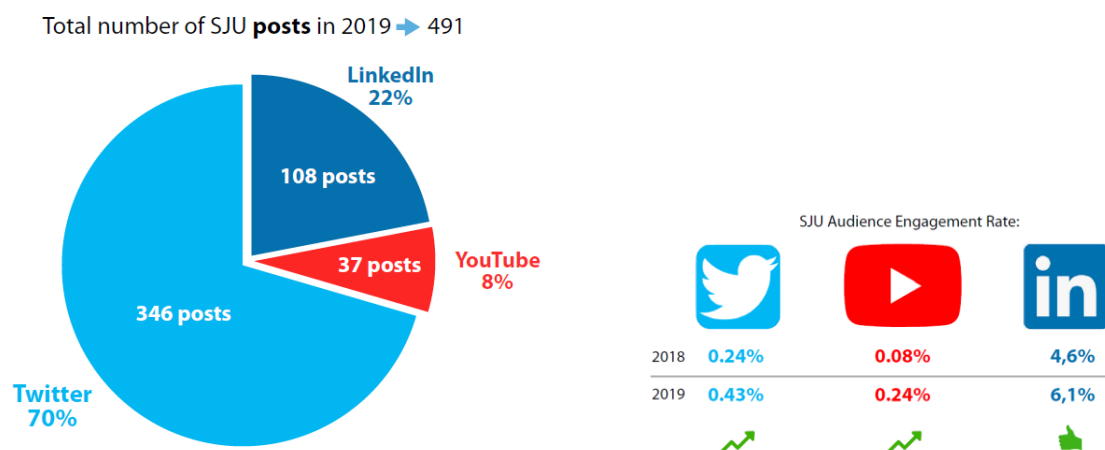
Figure 16: The SESAR JU on social media

All SESAR social media channels saw an improvement in their engagement rate between 2018 and 2019. The posts that generated the most engagement were on LinkedIn.

In terms of enlarging the online community, the SESAR JU has seen an increase in the number of followers, especially on LinkedIn. This may be due to the work (social media policy and training) done internally to encourage staff to become ambassadors for the SESAR JU on LinkedIn.

LinkedIn is the first SJU social media community, with a **growth rate** of **41%** between 2018-2019.
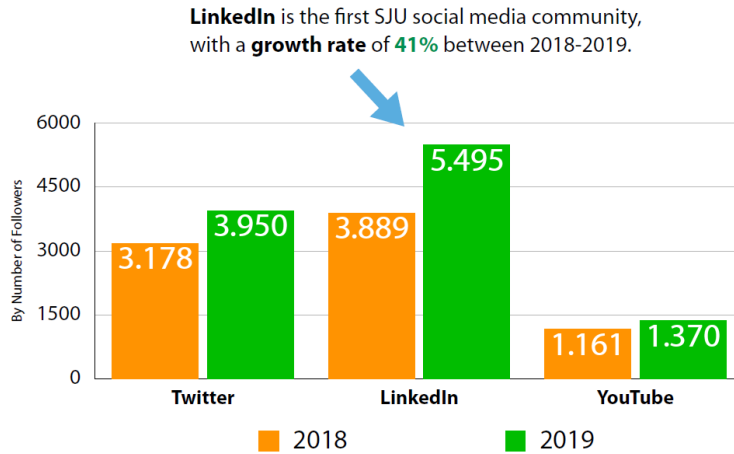
Figure 17: The SESAR JU's online communities by social media platform

Peaks in engagement rate and view in both channels were reported thanks to the increase of posts by the SESAR JU and their multiplier effect at key events during the year, especially World ATM Congress, SESAR Innovation Days, Digital Sky Challenge.

In 2019, the SESAR JU conducted reviews of the metrics and monitoring of its online communications in order to evaluate the value of this area of work and identify where best to concentrate its efforts. The reporting, which is done on a quarterly basis, provides hard data on the SESAR JU online channels, cross references social media with events and publications, benchmarks the SESAR JU against similar organisations, and offers recommendations on how to improve communications in this area.

Founding Members
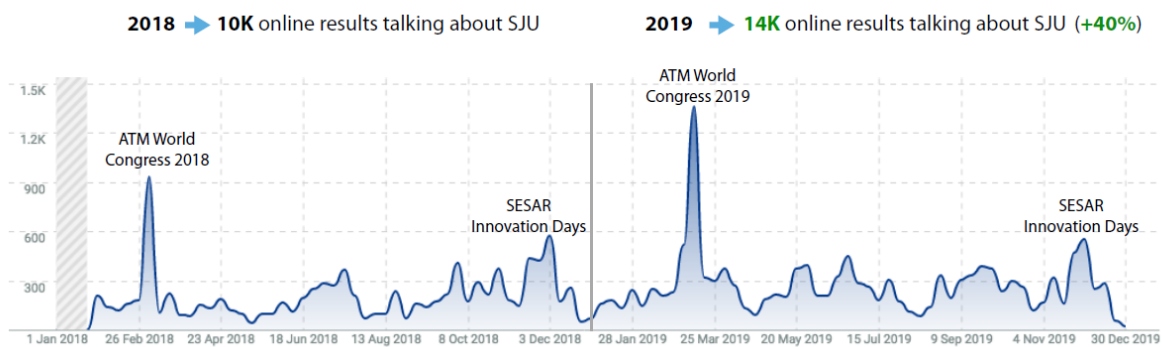
2.6 Strategic Area of Operation 6 (transversal activity): Deliver effective financial, administrative and corporate management

The SESAR JU met all its objectives related to effective financial, administrative and corporate management in 2019. This includes the following achievements and results:

- *Implement the call for proposal management framework: prepare/finalise the call material before launch and prepare the call evaluation (IR-VLD Wave 2 and ER4): the two calls were launched and proposals were evaluated. The IR-VLD Wave 2 call resulted in 13 grant agreements signed. The ER4 call evaluation resulted in an evaluation report ready to be submitted to the Executive Director, with a recommendation to award 29 grants (see Subsection 2.6.1)*
- *Prepare the call material (administrative and financial/budgetary aspects) for the VLD Open 2 2020 call (H2020-SESAR-2020-1) and for the IR Wave 3 call (H2020-SESAR-2020-2): the material for the two calls was prepared to allow for a launch of the calls for proposals in Q1 2020 (see Subsections 2.6.1, 2.1.4.3 and 2.4.1.4)*
- *Implement remaining recommendations of Commission's mid-term review of H2020 implementation and follow up audit recommendations and evaluations (IAS, ECA): all recommendations were implemented (see Section 3.8)*
- *Ensure full compliance with programming and reporting requirements: all programming and reporting requirements were fulfilled in due time and in accordance with the regulatory requirements (see Subsection 2.6.6)*
- *Monitor the Exception and Non-Compliance Events Register: two exceptions and three non-compliance events were registered in 2019 in the SESAR JU's Exception/Non-compliance events Register (see Section 3.12).*
- *Monitor the efficiency and effectiveness of the SESAR JU's legal and procurement activities: 30 contracts including 24 specific contracts, and the SESAR JU conducted eight procurement procedures in 2019 (see Subsections 2.6.4 and 2.6.5)*
- *Monitor efficiency and effectiveness of SESAR JU's project audit activities: the SESAR cumulative residual error rate is 1.61% (see Section 5.5)*
- *Monitor the efficiency and effectiveness of SESAR JU's financial activities (incl. audit of accounts by ECA): the SESAR JU executed 91.69% of its commitment appropriations and 82.66% of its payment appropriations, and completed SESAR 1 remaining financial transactions (see Subsection 2.6.2 and Section 3.3)*
- *Monitor the efficiency and effectiveness of SESAR JU's human resources (HR) activities: the vacancy rate at the end of 2019 was of 2.5% (see Subsection 2.6.3)*
- *Monitor the efficiency and effectiveness of SESAR JU's corporate and management activities. All corporate activities were delivered in due time and in accordance with the applicable regulatory requirements*
- *Deliver infrastructure services to enable teams and the SESAR JU to operate smoothly: infrastructure-related services and projects (ICT and facilities) have been in place and available to staff along the year 219 with no major interruption (see Subsections 2.6.8 and 2.6.9)*

In 2019, the SESAR JU 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 Subsections.

2.6.1 Implementation of calls for proposals and grant management framework

In 2019, the SESAR JU managed 85 grants already in execution in the beginning of the year, following six calls for proposals procedures conducted in years before. One project resulting from one of these calls for proposals of previous years (ER3) was selected and the grant signed in 2019. All these projects and the related grants are managed in accordance with the applicable programme rules, i.e. Horizon 2020 for 78 grants, Connecting Europe Facility for the six U-space demonstration projects, and the assigned revenue agreement for the GEOSAFE project.

In addition, two calls for proposals under the Horizon 2020 framework were launched in 2019: the restricted IR-VLD Wave 2 call (see above in Subsection 2.3.2) launched in January and closed in April 2019, and the ER4 call (see above in Subsection 2.2.3) launched in April and closed in August 2019. The call management and evaluation process took place as follows:

- The SESAR JU received 16 proposals in response to the IR-VLD Wave 2 call, for a total amount of EUR 157 918 620 (104% of the maximum call amount).
  - o Of the 16 proposals, 12 were related to transversal activities and industrial research (IR) and four to very large-scale demonstrations (VLDs). For the evaluation of the proposals, in accordance with the H2020 rules, the SESAR JU ran admissibility, eligibility, operational and financial capacity checks, which resulted in the rejection of one proposal.
  - o For the 15 remaining proposals, technical evaluations took place between the 20 May and the 28 June 2019, with the assistance of nine external experts. The evaluation was concluded by the submission of the evaluation report to the Executive Director, who followed the recommendation of the panels and awarded 15 projects.
  - o This decision triggered the grant agreement preparation phase, which was concluded in Q4 2019 for the 12 IR projects and for one demonstration project, and which is still ongoing at the end of 2019 for two demonstration projects.
- The SESAR JU received 128 proposals in response to the ER4 call, for a total amount of EUR 172 632 950 (448 % of the maximum call amount).
  - o For the evaluation of the proposals, in accordance with the H2020 rules, the SESAR JU ran admissibility, eligibility, operational and financial capacity checks, which resulted in the rejection of no proposal. The technical evaluations took place between the 10 October and the 22 November 2019, with the assistance of 48 external experts.
  - o The evaluation was concluded by the drafting of an evaluation report with the recommendation of the panels to award 29 projects. At the end of 2019, the evaluation report was ready to be submitted to the Executive Director.

Furthermore, the SESAR JU prepared two additional calls for proposals: one additional open call on very large-scale demonstration activities (VLD Open 2 call for proposals with reference H2020-SESAR-2020-1), and one last call, restricted to the SESAR JU Members other than the Union for industrial research & validation activities and very large-scale demonstrations (restricted call Wave 3 with reference H2020-SESAR-2020-2).

The sequence of all SESAR 2020 calls for proposals over the period from 2015 to 2022, with results at the end of 2019, can be depicted as follows:
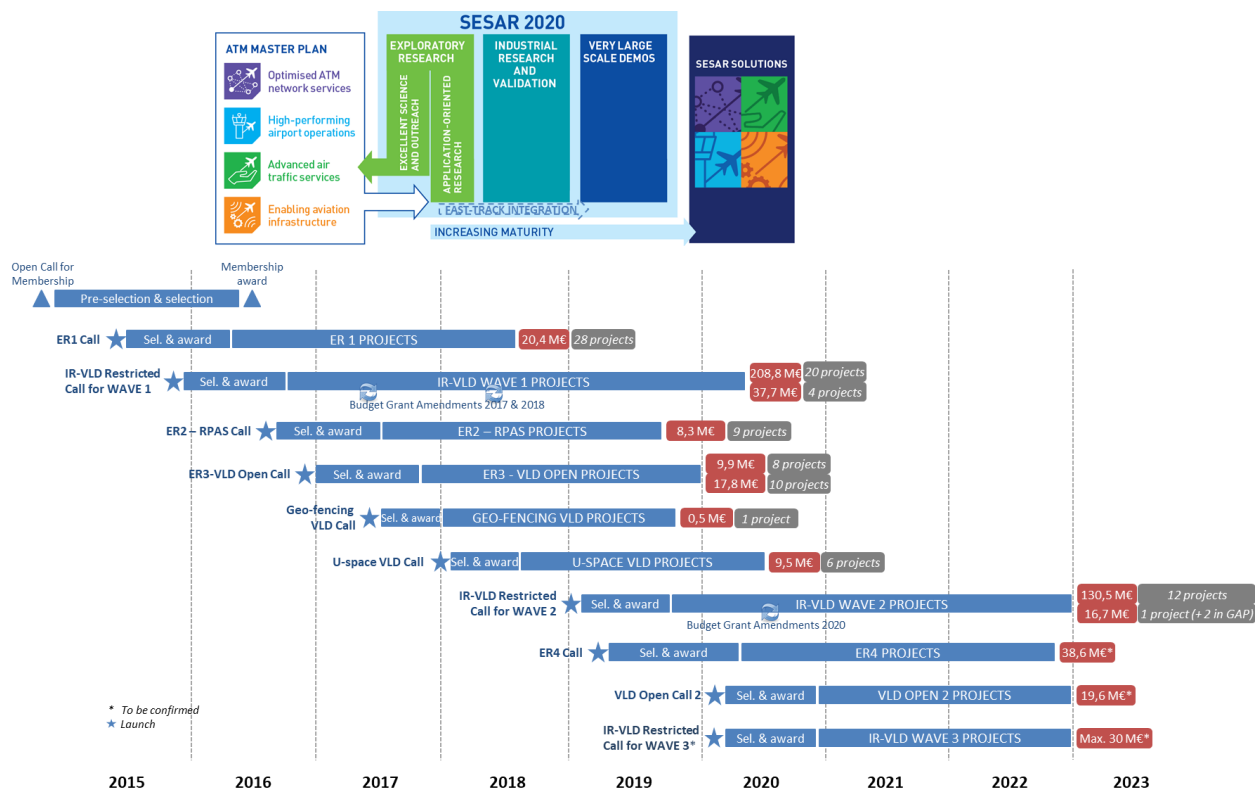
Figure 18: SESAR 2020 calls for proposals and their results as at the end of 2019

2.6.2   Financial management

The primary focus in the area of financial management was the implementation of budget. The results of this activity can be found in Section 3.3 below.

Additionally, the SESAR JU made several key improvements to its operations in 2019. These included in particular the drafting and submission of new Financial Rules to the Administrative Board, which were required following the publication by the Commission of the new Framework Financial Regulation. A number of derogation were discussed with the European Commission, and the revision process was concluded in October 2019 by the adoption of the new Financial Rules by the Administrative Board[43].

Furthermore, the SESAR JU continued strengthening its finance function with the adoption of a new organisation chart by the Administrative Board, which created the new position of Chief Financial Officer. As explained in the next section related to Human Resources management, this position was filled externally with the successful conclusion of the recruitment procedure, which must be followed by the arrival of the new staff member in January 2020.

Other achievements in the area of financial management are presented in Section 3.3.

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[43] SESAR JU Administrative Board decision ADB(D)21-2019 of 9 October 2019

2.6.3   Human Resources (HR) management

The SESAR JU staff consists of 39 Temporary and Contract Agents and three Seconded National Experts (SNEs), as per the Single Programming Document 2019.

The Staff Establishment Plan and its realisation are presented in Annex IV.

The effective allocation of staff resources also remained a priority for the SESAR JU during 2019. 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.

In 2019 the SESAR JU conducted its Career Development Review exercise and was able to conduct the reclassification of 6 temporary agents.

The vacancy rate at the end of 2019 was of 2.5 %. It should be noted that the SESAR JU Staff Establishment Plan only has 39 positions plus 3 SNEs positions, therefore each move in staff counts for more or less 2.5%.

During the last quarter of 2019, the selection process for the position of Chief Financial Officer took place in order to create a reserve list and the contract with the selected candidate was signed (for this position, filled externally, the recruitment process was finalised in January 2020 with the arrival of the selected candidate).

2.6.4   Legal support to operations in 2019

In 2019, specific legal expertise was provided to the organisation to contribute to:

- the regularity and legality of all SESAR JU's binding agreements, contracts, H2020 and non-H2020 grants (mainly U-space with five amendments to CEF grants), related amendments, SESAR JU decisions, processes, measures,

- the respect of the partnership principles agreed with SESAR JU members (membership agreement) and their development (including the signature and management of two secondment agreements);

- the respect of the agreements concluded with SESAR JU's founding members (EC Delegation agreements, the SESAR JU-Eurocontrol agreement);

- the development of the new SESAR JU financial rules, which were adopted by the SESAR JU's Administrative Board on 9 October 2019.
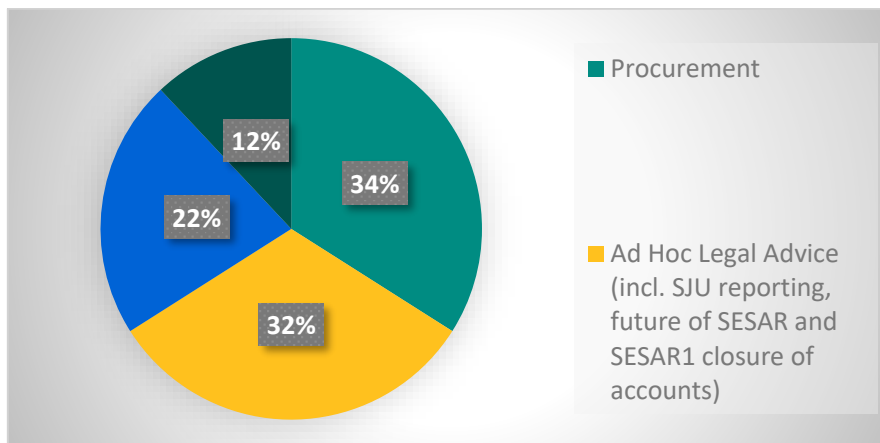
Figure 19: Breakdown of the SESAR JU's legal support to operations in 2019

Founding Members

Furthermore, in compliance with the applicable rules[44], the SESAR JU has dealt with three requests[45] for access to documents made by the public. As a result of a case-by-case basis analysis of each request, the SESAR JU has granted either full or partial access to the documents requested. Partial access was justified by invoking Article 4(1)(b) of Regulation (EC) No 1049/2001 regarding public access to European Parliament, Council and Commission documents[46], pursuant to which, access has to be refused if its disclosure would undermine the protection of privacy and the integrity of the individual, in particular in accordance with EU legislation regarding the protection of personal data. So far, no sensitive documents have been recorded in the register.

2.6.5   Procurement activities in 2019

Over 2019, the SESAR JU effectively implemented its Procurement Plan (as per annex IX to the Single Programming Document for 2019-2021) and signed 30 contracts including 24 specific contracts implementing SESAR JU framework contracts and inter-institutional agreements.

In 2019, there were eight procurement procedures: three negotiated procedures without prior publication of a contract notice (Point 11.1 (a) to (f) Annex 1 of the Financial Regulation (FR) and in Article 74(10) FR), four open calls for tender and one public contest. In addition, SESAR JU signed 13 amendments including five to its contracts and nine to its specific contracts.

All procedures were carried out in compliance with the SESAR JU's Financial Rules to ensure the respect of transparency, fair competition amongst suppliers and the most efficient use of SESAR JU funds. The procurement procedures supported the SESAR JU objectives transversally.

2.6.6   Corporate planning and reporting

Corporate programming documents and corporate planning

In 2019, the SESAR JU prepared three amendments to the Single Programming Document for 2019-2021 adopted by the Administrative Board through written procedures. These amendments included the inscription of unused 2018 appropriations into the 2019 budget (first amended version adopted through decision of the SESAR JU Administrative Board ADB(D)02-2019), updated ER4 call conditions and a procurement plan update (second amended version adopted through decision of the SESAR JU Administrative Board ADB(D)08-2019), and the alignment of the budget for 2020 with latest EU draft budget (third amended version adopted through decision of the SESAR JU Administrative Board ADB(D)13-2019).

Furthermore, in accordance with requirements of the Framework Financial Regulation, the SESAR JU further developed its Single Programming Document for 2020-2022, which was adopted by the Administrative Board on 17 December 2019 (ADB(D)24-2019). This adoption includes: the approval of

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[44] Article 15(3) of the Treaty on the Functioning of the European Union, Article 42 of the Charter of Fundamental Rights of the EU, Regulation (EC) No 1049/2001 of the European Parliament and the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents and Article 19 of the SESAR JU Statutes. These practical arrangements for the public access to documents of the SESAR JU are governed by Decision ADB(D)-12-011 of the Administrative Board of the SESAR Joint Undertaking *"Concerning the transparency and public access to the documents of the Joint Undertaking"* and by further internal rules of the SESAR JU (Executive Director's Decision SESAR JU/ED/683).

[45] Article 17 of Regulation (EC) No 1049/2001 sets forth that *"each institution shall publish annually a report for the preceding year including the number of cases in which the institution refused to grant access to documents, the reasons for such refusals and the number of sensitive documents not recorded in the register"*.

[46] Regulation (EC) no 1049/2001 of the European Parliament and of the Council of 30 may 2001 regarding public access to European Parliament, Council and Commission documents. OJ L 145, 31.5.2001, p. 43–48

the 2020 annual work programme, the financing decision for the launch of the second open call for very large-scale demonstrations (see paragraph 2.4.1.4 above) and IR-VLD Wave 3 in 2020, the financing decision of the adoption of the 2020 budget, the approval of the Staff Establishment Plan for 2020 and the approval of the Procurement Plan for 2020.

The SESAR JU also started off the drafting of its Single Programming Document for 2021-2023, in view of the submission of this document (in draft version) to the Authority by 31 January 2020.

Furthermore, following the revision of the Framework Financial Regulation, and seeking to implement its Article 32, the SESAR JU participated to the working group of the EU Agencies Network on proposals for the revision of the corporate planning documents template and guidelines[47].

Corporate reporting

In 2019, the SESAR JU released its CAAR for 2018, which the Administrative Board approved through written procedure on the 27 June 2019 (ADB(D)12-2019).

Moreover, the SESAR JU prepared and submitted Implementation Reports in response to the three delegation agreements.

The SESAR JU ensured reporting on its activities to the Administrative Board on a quarterly basis.

Furthermore, following the revision of the Framework Financial Regulation, and seeking to implement its Article 48, the SESAR JU participated to the working group of the EU Agencies Network on proposals for the revision of the corporate reporting documents template and guidelines[48].

Leverage effect

Building on the clarifications on the leverage effect calculation methodology in the CAAR for year 2018 (Part I, Subsection 2.6.5, pages 144 and 145), the SESAR JU uses three methods to present the leverage of the SESAR JU:

1. the method used by the European Commission in the context of the interim evaluation;

2. a method that is a refinement of the interim evaluation method but also includes all activities of the SESAR JU;

3. the method used by Horizon 2020.

Some readers also expect to see a leverage that describes the contribution of the beneficiaries of SESAR 2020 grants against that of the Union. As the industrial programme is only a part of the responsibility and work undertaken by the SESAR JU this must be calculated differently to be meaningful, a Partnership leverage is also calculated and will be consistently reported upon in this and future reports.

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[47] This working group provided advice and feedback to the European Commission, which was used by the European Commission for the publication of new guidelines on the establishment of the Single Programming Document, annex I to Communication from the Commission C(2020) 2297 final on the strengthening of the governance of Union Bodies under Article 70 of the Financial Regulation 2018/1046 and on the guidelines for the Single Programming Document and the Consolidated Annual Activity Report

[48] This working group provided advice and feedback to the European Commission, which was used by the European Commission for the publication of new guidelines on the establishment of the Consolidated Annual Activity Report, annex II to Communication from the Commission C(2020) 2297 final on the strengthening of the governance of Union Bodies under Article 70 of the Financial Regulation 2018/1046 and on the guidelines for the Single Programming Document and the Consolidated Annual Activity Report

The set of leverage targets, the raw data and calculation methods used are depicted in the following table.

		Cumulative Leverage (Reporting)			Forecast
Partnership Leverage (SESAR Programme)		**2017 Actual**	**2018 Actual**	**2019 Reported**	**Leverage**
1	Gross In-Kind contribution by Members	€126.483.823,00	€262.551.881,00	€375.608.825,30	€666.458.129,84
2	Co-Financing requested by Members	€70.472.006,00	€148.624.621,00	€211.469.129,23	€373.503.520,40
3	**Net In-Kind Contribution of Members**	€56.011.817,00	€113.927.260,00	€164.139.696,07	**€292.954.609,44**
4	Gross In-Kind contribution by Founding Member EUROCONTROL	€60.547.899,00	€121.203.159,00	€183.303.159,00	€485.454.673,00
5	Co-Financing requested by Founding Member EUROCONTROL	€945.174,00	€1.934.693,00	€3.015.486,88	€4.392.932,80
6	**Net In-Kind Contribution of Founding Member EUROCONTROL**	€59.602.725,00	€119.268.466,00	€180.287.672,12	**€481.061.740,20**
7	Net In-Kind contribution by Founding Member EU				
8	**EU Commitment Appropriations for Co-financing of Members & Founding Member**	€180.610.284,00	€180.610.284,00	€208.089.022,73	€377.896.453,20
	Calculation Partnership Leverage = ((3)+(6)+(7))/(8)	0,64	1,29	1,66	2,05
	Calculation Partnership Leverage = ((3)+(6)+(7)+(8))/(8)	1,64	2,29	2,66	3,05
Union Body Leverage (SESAR JU)		**2017 Actual**	**2018 Actual**	**2019 Reported**	
1	Net Contribution of Members (inc. cash)	€58.649.827,00	€119.203.280,00	€172.053.726,07	€314.570.913,09
2	Net Contribution of EUROCONTROL (inc. cash)	€66.284.725,00	€129.150.466,00	€191.169.672,12	€506.398.680,32
3	Net In-Kind contribution by Founding Member EU				
4	Net Contribution from Open calls (ER + VLD-Open) after	€14.147.995,00	€14.147.995,00	€14.147.995,00	€23.000.000,00
5	Total EU Commitment Appropriations available to the SJU	€236.148.000,00	€348.711.000,00	€461.329.000,00	€585.000.000
6	EU Commitment Appropriations available to the SJU for ER				
	Target Leverage established by Regulation = ((1)+(2)+(3))/(5-6)				
	Target Leverage established by Interim Evaluation = ((1)+(2)+(3))/(5)	0,53	0,71	0,79	1,40
	Calculation of SJU Union Body Leverage = ((1)+(2)+(3)+(4))/(5)	0,59	0,75	0,82	1,44
	Calculation of SJU Union Body Leverage = ((1)+(2)+(3)+(4)+(5))/(5)	1,59	1,75	1,82	2,44

Table 5: Cumulative leverage for the programme and the SESAR JU

It should be noted that these figures are estimates and that actual figures will be added in Q2 2020 in line with the RP3 reports received from the SESAR JU members.

This table shows that, as reported last year already, the actual leverage of the SESAR JU and the SESAR 2020 programme regularly progresses towards the targets.

2.6.7 Corporate Quality Management

In 2019, the SESAR JU maintained its Quality Management System (QMS) and its Information & Document Management System (IDMS) following a continuous improvement approach. This includes in particular the further integration of the Internal Control Framework (EC ICF) with the QMS.

The results of the assessment against the Internal Control Framework are provided in Section 5.2.

2.6.8 Information and communication technologies (ICT) management

In 2019, the SESAR JU ICT continued using and developing the support services delivered by Eurocontrol following the migration of the whole infrastructure towards them in 2016, implementing provisions of Schedule 4 of the SESAR JU – Eurocontrol agreement. Continuous improvements processes in place, strong working relationships between the SESAR JU ICT and the supplier combined with new initiatives for transformation, innovation and risk mitigation contributed to keep a high level of quality for the support service delivered during the whole year while keeping the costs of the support service stable and under control (about -1.4% compared to previous year).

Regarding the transformation projects, all approved by the SESAR JU Corporate Quality and ICT Governance (QICT) Committee involving all the SESAR JU sectors, a particular attention was given to initiatives related to guaranteeing the continuity of the service, either by anticipating some obsolescence, such as the replacement of the outdated telephony system, or by controlling risks, such as adding redundancy within some systems in order to avoid possible single points of failure or

increasing the remote monitoring capabilities or improving the capacity to carry on in case of disasters or major incidents.

All the transformation projects foreseen in 2019 were delivered during the course of the year. Only a couple of initiatives were not fully deployed and postponed until the first quarter of 2020, following the proposal from SESAR JU ICT Coordinator approved by the SESAR JU QICT Committee, to accept a system freeze period at year-end when the capacity of the ICT support organisation is smaller.

2.6.9 Facilities management

In 2019, work continued on a number of initiatives in SESAR JU's premises in Brussels to maintain the productivity, safety and efficiency of the working environment and facilities offered to SESAR JU staff.

The open call for tender SESAR JU/LC/0146, covering reception and back-office reception services was positively concluded with the award of one service contract in 2019.

2.6.10 Travel coordination

In 2019, the SESAR JU staff have achieved a total of 244 missions (not including missions related to the activities managed by the Programme Management Unit under the SESAR JU – Eurocontrol agreement), an increase by 5% in the number of missions compared to 2018. This represents a significant investment of time and money to ensure the SESAR JU plays an active role in steering the activities conducted with the support of its stakeholders.

It has to be noted that the SESAR JU has made an extensive use of web conferences, especially for recurring monitoring activities such as project reviews. Typically, for meetings related to ER, IR and VLD and except for critical meetings such as kick-off meetings and critical reviews, the SESAR JU has encouraged to opt for web conferences to coordinate with grant beneficiaries by preference, which represents a significant benefit in terms of environmental footprint, efficiency and work-life balance. This is the reason why, out of the 244 missions, 116 (48 %) are related to SESAR Outreach (Strategic Area of Operation #5) and 44 (18 %) to Strategic Steering (in particular, missions related to the delivery of the mandate on the Airspace Architecture Study and the Master Plan update campaign, see above in paragraph 2.1). The split and allocation per Strategic Area of Operation, and within Strategic Area of Operation #5, by topic, is depicted in the following figure:
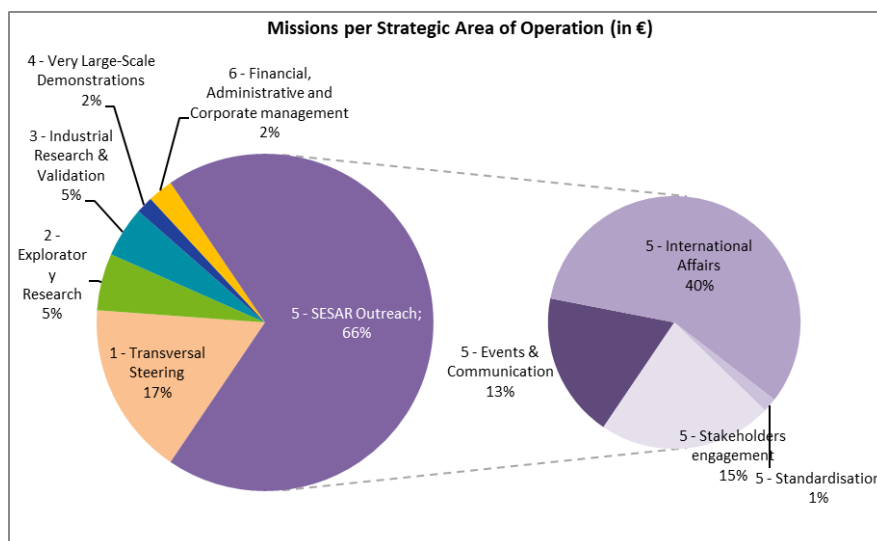
Figure 20: Breakdown of SESAR JU missions by Strategic Area of Operation (in percentage)

Mission management was executed on time and in line with the rules of the EC Mission Guide.

2.6.11 Internal control, risk management and audit

Actions related to Internal Control, Risk Management and Audit are addressed in Part IIa, Section 3.8 and in Part III of this report.

2.6.12 Data protection

The year 2019 sets the first year of implementation of the new data protection regulation ('Regulation 1725' or 'new data regulation')[49], and the SESAR JU performed a series of actions in order to ensure accountability and a long-term commitment into a privacy practice and culture, which the SESAR JU strictly observes and applies.

Within the first year of implementation of the Regulation, the readiness for the entry into force required the Data Protection Officer (DPO) to provide legal advice, a thorough assessment and guidance.

Whereas most of the novelties and requirements of Regulation 1725 had already been embedded by the SESAR JU, tracked through the monitoring of the Action Plan, there are ongoing actions to be performed within the upcoming years. In addition, through the accountability principle, Regulation 1725 sets the obligation of not only ensure compliance but also the obligation of demonstration and verification of such compliance.

The concrete outputs in terms of data protection at the SESAR JU for the year 2019 are summarised as follows:

- Transformation of the system of records into and online register. This was the outcome of a joint procurement with the other JUs for which the inception phase was completed in 2019. The new register is meant to be available in SESAR JU's public web by 2020. A further step into the need for "publicity" of the system of records.

- Ongoing drafting of the SESAR JU policies: Rules on restriction of access to rights from data subjects. The drafting exercise has been done in cooperation with the other JUs and approval process will continue through 2020.

- Dissemination and info sessions across the SESAR JU, extensive advice to colleagues and SESAR JU Executive Director in his responsibility as SESAR JU controller, as well as contribution to reporting obligations.

- Notification on data breaches. The SESAR JU registered its first data breach on December 2018, there were follow up actions over 2019.

In addition to concrete output, 2019 was a year of extensive cooperation with stakeholders in the area of Joint Controllership, figure highly emphasised by Regulation 1725 and under the strict scrutiny of the European Data Protection Supervisor (EDPS):

- participation in the pilot working group on Co-controllership (with different representatives of the EUIs of the Research family and the European Commission), and preparation of the first draft of the MoU on Joint Controllership for the processings impacting the Research family.

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[49] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC

- a second meeting with Eurocontrol for the purpose of the joint controllership elements pertaining the SESAR JU/Eurocontrol agreement.

2.6.13 Participation to support and coordination groups in 2019

In 2019, SESAR JU staff participated in a number of Horizon 2020 coordination groups:

- Common Implementation Centre related (CIC) – (four meetings amounting to 8 hours),
- Grant Management Steering Committee (two meetings amounting to 2 hours),
- Grant Management Key User Group (five meetings),
- Proposal Submission and Evaluation Steering Committee (two meetings),
- CORDA Steering Committee and Key User Group (three meetings),
- Expert Management Steering Committee and Key User Group (four meetings),
- H2020 Legal Mechanism Issue Group (nine meetings),
- CIC Executive Committee (three meetings amounting to 7 hours),
- Other CIC group (five meetings amounting to 10 hours).

In addition, the SESAR JU is a regular participant to the meetings of the EU Agencies Network (EUAN):

- Heads of Agencies (two meetings amounting to 15 hours),
- Heads of Admin (two meetings amounting to 20 hours),
- Network of Agencies Procurement Officers (NAPO) (one meeting),
- Inter-Agency Legal Network (IALN) (two meetings),
- Network of DPOs (Data Protection Officer) of EU Institutions and Bodies (two meetings).

The SESAR JU also maintained a regular relationship with the EC DG MOVE-DG ENER Shared Resource Director.

2.7 Overall conclusion on the SESAR JU's achievements in 2019

Building on the achievements of previous years, 2019 was a new year of delivery for the SESAR Joint Undertaking, which progressed towards the achievement of its strategic objectives over the period from 2014 to 2024, but also prepared the future research and innovation activities in ATM.

All achievements of 2019 were done in full compliance with applicable regulations.

With the successful execution of its work programme for 2019, and in line with the provisions set forth in its successive Single Programming Documents, the SESAR JU paved the way to further deliver results in the upcoming years and to contribute to the implementation of the objectives of the Single European Sky initiative and towards a Digital European Sky.

3 Part IIa. Management Evaluation

3.1 Administrative Board

In 2019, the Administrative Board held three plenary meetings and adopted 20 decisions through written procedures. The main focus of the Administrative Board was to follow up the achievement of the SESAR JU's work programme for 2019 (as described in Part I of this document) and the management of major risks (as documented in Section 5.1). Furthermore, in 2019, the SESAR JU Executive Director proposed to the Administrative Board to adopt a number of decisions related to Implementing Rules of the Staff Regulation.

In this regard, the Administrative Board adopted the following decisions in 2019:

Subject	Type of decision	Date of adoption
Approving the draft Single Programming Document 2020-2022	Written procedure	30.01.2019
Single Programming Document 2019-2021 Amendment n.1	Written procedure	07.02.2019
Approving of the IAC Annual Audit Plan 2019	Written procedure	01.03.2019
Temporary occupation of management posts	Written procedure	28.03.2019
Middle management staff	Written procedure	28.03.2019
Function of advisers	Written procedure	28.03.2019
Validation of in-kind contribution	Written procedure	07.05.2019
Single Programming Document 2019-2021 Amendment n.2	Written procedure	24.04.2019
Allocation of voting rights	ADB(M)046-2019	07.05.2019
Appointment of the Board's Vice-Chairperson	ADB(M)046-2019	07.05.2019
Revised SESAR JU organisation chart	Written procedure	06.06.2019
CAAR 2018	Written procedure	27.06.2019
Single Programming Document 2019-2021 Amendment n.3	Written procedure	26.07.2019
Laying down general implementing provisions regarding Art. 54 CEOS	Written procedure	04.11.2019
General implementing provisions regarding Art. 87(3) CEOS	Written procedure	04.11.2019
Working time	Written procedure	04.11.2019
Framework for Learning and Development	Written procedure	04.11.2019
General provisions for implementing Art. 79(2) CEOS governing conditions of employment of contract staff under Art.3(a)	Written procedure	04.11.2019
Request for the non-application of Commission rules on administrative inquiries and disciplinary proceedings	Written procedure	04.11.2019
Specific Amendment Procedure based on Budgetary Grounds for SESAR 2020 IR-VLD Actions	Written procedure	13.09.2019
SESAR JU Financial Rules	Written procedure	09.10.2019
SESAR JU Annual Accounts 2018	Written procedure	17.12.2019

Subject	Type of decision	Date of adoption
Approval of the ATM Master Plan 2020 edition	ADB(M)048-2019	17.12.2019
Adoption of the Single Programming Document 2020-2022	ADB(M)048-2019	17.12.2019

Table 6: Administrative Board decisions in 2019

3.2   Major developments

The SESAR JU receives funds of various origins from the European Commission in order to execute the SESAR 2020 programme.

Originally delegated through the Horizon 2020 framework, a first Assigned Revenue mandate was assigned to the SESAR JU in 2016 for the action on Active Geo-fencing.

In 2019, following the signature of delegation agreements between the Commission and the SESAR JU in the previous years, the SESAR JU operates under four different sources of funding, each referring to the execution of grants (following calls for proposals) or studies (following calls for tender). This diversity of applicable legal frameworks under which the SESAR JU operates, with each its own templates and obligations, also comes with a high degree of complexity due to the number of derogations to the legal frameworks which have been defined in the corresponding delegation agreements.

3.3   Budgetary and financial management

3.3.1   Annual budget for the year 2019

The 2019 budget approved by the SESAR JU's Administrative Board , included revenue (cash forecasted to be received, additional appropriations coming from carry-overs and internal assigned revenues) of EUR 119 572 762[50] and payment appropriations (cash forecasted to be spent) of EUR 125 688 287[51] (only SESAR 2020 – no revenue was forecast for SESAR 1).

In terms of expenditure, the budget presented total available commitment appropriations of EUR 161 041 597 (of which EUR 1 195 809 for SESAR 1 and EUR 159 845 788 for SESAR 2020) and a total of payment appropriations of EUR 183 279 715 (of which EUR 1 750 624 for SESAR 1 and EUR 181 529 090 for SESAR 2020), composed as follows:

- initial commitment appropriations of EUR 100 869 667, re-inscription of budget outturn and carry-overs from previous years of EUR 18 703 094, re-inscription of unused appropriations from previous years of EUR 30 985 560 and internal assigned revenues for an amount of EUR 10 483 276.

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[50] EUR 150 558 321 knowing that unused appropriations from previous years: EUR 30 985 560 are deducted from previous years revenue commitment appropriations (when uploading the amending budget, C2 inscriptions are only posted in expenditure and are deducted in revenue from previous years).

[51] EUR 169 857 198 knowing that unused appropriations from previous years: EUR 44 168 911 are deducted from previous years revenue commitment appropriations (when uploading the amending budget, C2 inscriptions are only posted in expenditure and are deducted in revenue from previous years).

- initial payment appropriations of EUR 113 917 411, re-inscription of budget outturn and carry-overs from previous years of EUR 11 770 876, re-inscription of unused appropriations from previous years of EUR 44 168 911 and internal assigned revenues for an amount of EUR 13 422 517.

3.3.2 Implementation of the budget for the year 2019

3.3.2.1 Revenue

The revenues established (recovery orders issued) amount to EUR 124 777 771 (104.4% of the approved budget and of out which EUR 113 733 525 is EU contribution under the H2020 programme) and revenue actually received to EUR 124 777 771 (99.28% of the approved budget and out of which EUR 113 733 525 as EU contribution).

The tables below provide a breakdown of revenues per revenue sources[52] (for SESAR 1 and SESAR 2020 in total, then for SESAR 2020 and SESAR 1 separately):

SESAR 1 + SESAR 2020

all figures in EUR	1	2	3=2/1	4	5	6=5/4	7	8
Type of revenue	Commitment appropriations	Actual Revenues established /carried over	% of budget	Payment appropriations	PA execution	% of budget	Outstanding (from 2019 only)	Outstanding (Total)
Contribution from the European Union	112.618.000	113.733.525	101,0%	111.733.525	113.733.525	101,8%	0	320.929.132
Assigned Revenues	0	402.657	0,0%	0	402.657	0,0%	0	6.247.343
Contribution from Eurocontrol	3.867.751	1.848.266	47,8%	3.867.751	1.848.266	47,8%	0	11.280.590
Contributions from other Members	3.087.011	2.729.585	88,4%	3.087.011	2.729.585	88,4%	0	13.190.036
Other sources of contribution and revenue	0	6.063.737	0,0%	7.000.000	6.063.737	86,6%	0	0
TOTAL REVENUE	**119.572.762**	**124.777.771**	**104,4%**	**125.688.287**	**124.777.771**	**99,28%**	**0**	**351.647.101**

SESAR 2020

all figures in EUR	1	2	3=2/1	4	5	6=5/4	7	8
Type of revenue	Commitment appropriations	Actual Revenues established /carried over	% of budget	Payment appropriations	Actual Revenues received	% of budget	Outstanding (from 2019 only)	Outstanding (Total)
Contribution from the European Union	112.618.000	113.733.525	101,0%	111.733.525	113.733.525	101,8%		255.065.306
Assigned Revenues		402.657	0,0%		402.657	0,0%		6.247.343
Contribution from Eurocontrol	3.867.751	1.848.266	47,8%	3.867.751	1.848.266	47,8%		11.280.590
Contributions from other Members	3.087.011	2.729.585	88,4%	3.087.011	2.729.585	88,4%		13.190.036
Other sources of contribution and revenue		5.148.227	0,0%	7.000.000	5.148.227	73,5%		
TOTAL REVENUE	**119.572.762**	**123.862.261**	**103,6%**	**125.688.287**	**123.862.261**	**98,55%**	**0**	**285.783.275**

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[52] In CA: EUR 30 985 560 (re-inscription of unused appropriations from previous years) are deducted from previous years CA.
In PA: EUR 44 168 911 (re-inscription of unused appropriations from previous years) are deducted from previous years PA.

SESAR 1

all figures in EUR	1	2	3=2/1	4	5	6=5/4	7	8
Type of revenue	Commitment appropriations	Actual Revenues established/carried over	% of budget	Payment appropriations	Actual Revenues received	% of budget	Outstanding (from 2019only)	Outstanding (Total)
Contribution from the European Union			0,0%			0,0%		65.863.826
Contribution from Eurocontrol			0,0%			0,0%		
Contributions from other Members			0,0%			0,0%		
Other sources of contribution and revenue		915.510	0,0%		915.510	0,0%		
TOTAL REVENUE	**0**	**915.510**	0,0%	**0**	**915.510**	0,00%	**0**	**65.863.826**

3.3.2.2   Expenditure

In terms of expenditure, the total commitments made amounts to EUR 147 659 809 (91.69 % of the total available appropriations budget, out of which 92.36 % for SESAR 2020 available appropriations and 2.70% for SESAR 1 available appropriations). The total payments executed amount to EUR 151 504 679 which is 82.66 % of the total available budget: out of this amount, EUR 885 282 are for SESAR 1 (50.57% of the total available appropriations) and EUR 150 619 397 are for SESAR 2020 (82.97 % of the total available appropriations).

With the SESAR JU being a multi-annual programme (with a limited life-time and 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. The budget result for 2019 (i.e. total payment appropriations in revenues of EUR 124 777 771 minus EUR 151 504 679 total payments) amounts to a deficit of EUR 26 726 908 (a deficit of EUR 26 757 136 for SESAR 2020 and a surplus of EUR 30 228 for SESAR 1). The 2019 cumulative surplus that remains within the Joint Undertaking amounts to EUR 50 240 390 (of which EUR 19 550 729 for SESAR 2020 and EUR 30 689 661 for SESAR 1).

The table below provides a breakdown of expenditures by title (for SESAR 1 and SESAR 2020 in total, then for SESAR 2020 and SESAR 1 separately):

Founding Members

SESAR 1 + SESAR 2020

Type of expenditure	1	2	3=2/1	4	5	6 = 4 + 5	5=9+10	6=5/4	8	9	10
	Final Commitment appropriations	Commitments		Payment appropriations			Payments		Commitments still to be paid	Payments (against commitments of the year)	Payments (against previous years' commitments)
			% of budget	Budget 2019	from 2018*	Total		% of budget	(Total)		
Staff Expenditure	6.054.981	5.585.740	92,3%	6.054.981	329.074	6.384.055	5.325.094	83,4%	379.987	5.205.754	119.341
Administrative Expenditure	3.670.003	3.161.028	86,1%	3.670.003	819.741	4.489.743	2.448.741	54,5%	1.093.290	2.026.870	421.871
Operating Expenditure	151.316.614	138.913.040	91,8%	128.237.006	44.168.911	172.405.917	143.730.844	83,4%	147.151.444	108.118.221	35.612.623
1. Providing strategic steering to the SESAR programme	7.741.986	7.741.986	100,0%	2.599.158	1.078.145	3.677.303	2.856.313	77,7%	5.685.780	2.599.158	257.155
2. Deliver exploratory research	40.758.090	38.824.361	95,3%	17.857.927	1.681.025	19.538.952	10.866.563	55,6%	55.550.024	9.898.049	968.515
3. Deliver industrial research and validation	67.018.805	67.018.805	100,0%	89.293.374	37.133.763	126.427.137	112.186.666	88,7%	60.252.437	82.960.974	29.225.692
4. Deliver very large-scale demonstration activities	32.286.523	22.980.232	71,2%	14.920.923	4.275.979	19.196.901	15.196.901	79,2%	23.560.333	10.920.923	4.275.979
5. Deliver SESAR outreach	2.315.400	2.315.400	100,0%	1.815.000	0	1.815.000	1.739.117	95,8%	2.102.870	1.739.117	0
SESAR 1 Programme	1.195.809	32.255	2,7%	1.750.624	0	1.750.624	885.282	50,6%	4.127	0	885.282
TOTAL EXPENDITURE	161.041.597	147.659.809	91,69%	137.961.990		183.279.715	151.504.679	82,66%	148.624.721	115.350.845	36.153.834
TOTAL REVENUE							124.777.771				
BUDGET RESULTS							(26.726.908)				

only amounts needed in 2019(if any)

Table 7: Budget execution

SESAR 2020

all figures in EUR	1	2	3=2/1	4	5	6 = 4 + 5	7	8=7/6	10	5	7
Type of expenditure	Final Commitment appropriations	Commitments		Payment appropriations			Payments		Commitments still to be paid	Payments (against commitments of the year)	Payments (against previous years' commitments)
			% of budget	Budget 2019	from 2018*	Total		% of budget	(Total)		
Staff Expenditure	6.054.981	5.585.740	92,3%	6.054.981	329.074	6.384.055	5.325.094	83,4%	379.987	5.205.754	119.341
Administrative Expenditure	3.670.003	3.161.028	86,1%	3.670.003	819.741	4.489.743	2.448.741	54,5%	1.093.290	2.026.870	421.871
Operating Expenditure	150.120.804	138.880.785	92,5%	126.486.382	44.168.911	170.655.293	142.845.562	83,7%	147.151.444	108.118.221	34.727.340
1. Providing strategic steering to the SESAR programme	7.741.986	7.741.986	100,0%	2.599.158	1.078.145	3.677.303	2.856.313	77,7%	5.685.780	2.599.158	257.155
2. Deliver exploratory research	40.758.090	38.824.361	95,3%	17.857.927	1.681.025	19.538.952	10.866.563	55,6%	55.550.024	9.898.049	968.515
3. Deliver industrial research and validation	67.018.805	67.018.805	100,0%	89.293.374	37.133.763	126.427.137	112.186.666	88,7%	60.252.437	82.960.974	29.225.692
4. Deliver very large-scale demonstration activities	32.286.523	22.980.232	71,2%	14.920.923	4.275.979	19.196.901	15.196.901	79,2%	23.560.333	10.920.923	4.275.979
5. Deliver SESAR outreach	2.315.400	2.315.400	100,0%	1.815.000	0	1.815.000	1.739.117	95,8%	2.102.870	1.739.117	
TOTAL EXPENDITURE	159.845.788	147.627.554	92,36%	136.211.365		181.529.090	150.619.397	82,97%	148.624.721	115.350.845	35.268.552
TOTAL REVENUE							123.862.261				
BUDGET RESULTS							(26.757.136)				

SESAR 1

all figures in EUR	1	2	3=2/1	4	5	6 = 4 + 5	7	8=7/6	10	5	7
Type of expenditure	Final Commitment appropriations	Commitments		Payment appropriations			Payments		Commitments still to be paid	Payments (against commitments of the year)	Payments (against previous years' commitments)
			% of budget	Budget 2019	from 2018*	Total		% of budget	(Total)		
Staff Expenditure			0,0%			0		0,0%			
Administrative Expenditure			0,0%			0		0,0%			
Operating Expenditure	1.195.809	32.255	2,7%	1.750.624		1.750.624	885.282	50,6%	4.127	0	885.282
1. Studies/Development conducted by the SJU	28.128	28.128	100,0%	552.744		552.744	437.512				437.512
2. Studies/Development conducted by other Members	1.167.682	4.128	0,4%	1.197.880		1.197.880	447.770		4.127		447.770
TOTAL EXPENDITURE	1.195.809	32.255	2,70%	1.750.624		1.750.624	885.282	50,57%	4.127	0	885.282
TOTAL REVENUE							915.510				
BUDGET RESULTS							30.228				

only amounts needed in 2019 (if any)

Table 8: Number and value of Budget transfers

In 2019, no interest rates were charged for late suppliers payments.

3.3.3 SESAR 2020 multi-annual budget execution

The actual execution rate in terms of revenues committed (revenues established and recognised) reaches 77.7 % and 56.1 % for executed payments.

The validated in-kind contribution[53] reaches EUR 234 895 781 (31.7 % of the total estimated in-kind contribution in the SESAR JU membership agreement). This in-kind contribution validation concerns activities performed by the SESAR JU members other than the Union from the end of 2016 until the end of 2018:

Multi-annual revenues

all figures in EUR	1	2					3	4=2-3
			Revenues/Contributions actually received ('Payments')					
I. CASH CONTRIBUTIONS	SESAR 2020 Progamme Maximum	Total Entitlements ('Commitments')	2016	2017	2018	2019	Total 2016-2024	Open Entitlements still to be received
EUROPEAN UNION CONTRIBUTION *H2020 funds*	585.000.000	461.329.000	56.519.225	75.497.292	84.184.652	113.733.525	329.934.694	123.671.000
EUROPEAN UNION CONTRIBUTION *Assigned revenue*	11.300.000	11.300.000		650.000	4.000.000	402.657	5.052.657	0
CONTRIBUTION FROM EUROCONTROL	25.000.000	13.719.410		6.682.000	5.189.144	1.848.266	13.719.410	0
CONTRIBUTION FROM OTHER MEMBERS	18.466.056	5.276.020			2.546.435	2.729.585	5.276.020	0
OTHER REVENUE	0	5.191.900		24.704	18.968	5.148.227	5.191.900	0
Total CASH Contributions	639.766.056	496.816.330	56.519.225	82.853.996	95.939.199	123.862.261	359.174.681	123.671.000
Cumulative Budget implementation rates (of Prog. Max.):		77,7%					56,1%	

II. IN-KIND CONTRIBUTIONS IKC (validated by the SJU)

						(1)		
IKC from EUROCONTROL	433.418.444	59.602.725			59.602.725	61.164.500	120.767.225	312.651.219
IKC from OTHER MEMBERS	307.372.404	107.576.087			54.234.818	59.893.738	114.128.556	193.243.848
Total IN-KIND Contributions	740.790.848	167.178.812	0	0	113.837.543	121.058.238	234.895.781	505.895.067
Cumulative Budget implementation rates (of Prog. Max.):		22,6%					31,7%	

III. TOTAL CONTRIBUTIONS (I.+II.)	1.380.556.904	663.995.142	56.519.225	82.853.996	209.776.742	244.920.498	594.070.462	629.566.067
Cumulative Budget implementation rates (of Prog. Max.):		48,1%					43,0%	

(1) EUR 61.164.500 for EUROCONTROL and EUR 6.552.469 (out of EUR 59.893.738) for the Other Members are not yet validated

On expenditure side, the commitments made reach almost 69% of the total programme forecasts and payments made 53% of the total programme's forecasts:

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[53] EUR 61 164 500 for Eurocontrol and EUR 6 552 469 (out of EUR 59 893 738) for the Other Members are not validated yet.

Founding Members

Multi-annual expenditure

all figures in million EUR	1	2				3	

I. Expenditure Budget Titles:	SESAR 2020 Programme Maximum	Total Commitments made	PAYMENTS				
			2016	2017	2018	2019	Total 2016-2024
Running Costs (Titles 1 & 2)	72.716.056	26.024.963		6.089.978	9.270.138	7.773.835	23.133.951
Operational Expenditure Non-Members (Title 3.1)	169.050.000	87.397.145	9.919.493	15.443.239	15.440.464	15.904.159	56.707.355
Operational Expenditure Members (Title 3.3)	398.000.000	325.380.043	40.000.000	40.827.960	52.074.908	126.941.403	259.844.271
TOTAL Expenditure :	639.766.056	438.802.150	49.919.493	62.361.177	76.785.510	150.619.397	339.685.577
Cumulative Budget implementation rates (of Prog. Max.):		68,6%					53,1%

II. Budget Results

Cash Contributions (see Multi-annual revenues)	639.766.056	496.816.330	56.519.225	82.853.956	95.939.199	123.862.261	359.174.641
Budget Result (Revenues ./. Expenditure)	*0*	*58.014.180*	*6.599.732*	*20.492.779*	*19.153.689*	*-26.757.136*	*19.489.064*

3.3.4   Financial closure of the SESAR 1 programme

For SESAR 1, the commitment and payment implementation rate was a direct consequence of the winding-up of the programme and the financial closure of the SESAR 1 projects. In contrast, the good implementation rates of the SESAR 2020 programme show that H2020 projects are at their maximal growth level and SESAR 2020 programme is in a ramping phase.

Excess of Financial Contributions

The projects of the SESAR 1 Programme were closed by 31 December 2016. Following ex-post audit corrections, the financial and administrative closure of the Programme was finalised in December 2019 (with the exception of an amount of EUR 81 564 to be recovered in the first quarter of 2020 and an ex-post audit desk review for EUR 4 128 to be paid in the first quarter of 2020).

Because of that closure, the SESAR JU determined an excess of financial contributions received from its Members for the SESAR 1 programme, amounting to EUR 30 767 098. According to Article 13 of the SESAR JU's constituent act, the JU's members can only expect the reimbursement of their respective excess contributions at the dissolution of the SESAR JU by 31 December 2024, unless the JU's Administrative Board decides beforehand on a proposal to the Commission on the dissolution of the SESAR JU. Nevertheless, following the recommendation by the European Commission, the SESAR JU started in 2019 the preparation of an Administrative Board's decision on the reimbursement of the excess of financial contributions for SESAR 1.

To ensure budget adequacy for executing the repayments, the Administrative Board will instruct in the 2nd quarter 2020 the SESAR JU to record the cumulated Budget Outturn of EUR 30 767 098 in the Statement of Revenue and in the Statement of Expenditure under Chapter 3.3 ('Other members operating expenditure S1').

Overview of SESAR 1 programme execution

The actual overall programme execution rate is at 90.0 %, and this rate is 92.8 % for Title 3 only:

	Commitment made	Payments made	Total programme	% Payments execution
Title 1	46.629.036	40.596.071	55.000.000,00	73,8%
Title 2	28.010.735	24.838.991	42.824.088,75	58,0%
Title 3	778.627.622	737.729.330	795.000.000,00	92,8%
Total	853.267.393	803.164.392	892.824.088,75	90,0%

Table 9: Budget execution for the SESAR 1 programme

Furthermore, in 2019, the SESAR JU finalised the process of financial and administrative closure of SESAR 1 (operational closure end 2016), with the exception of an amount of EUR 71 422.25 to be recovered in the first quarter of 2020. Therefore, the cash situation in the first quarter of 2020 will be as follows:

	Revenue to be received in 2020	Payment to be done in 2020	Cash at year end 2019
Ex-post audit cots		(4.127,50)	30.689.661,47
Ex-post audit adjustments	81.564,25		
	-		
Balance Q1 2020	**81.564,25**	**(4.127,50)**	**30.767.098,22**

3.3.5   In-kind contributions

3.3.5.1   Annex I of the SESAR JU budget – in-kind contributions (revenue), SESAR 2020

In Kind contributions (Revenue) SESAR 2020

all figures in EUR	1	2	3=2/1
Type of revenue	**Commitment appropriations**	**CA execution**	**% of budget**
Contribution from the European Union	0	0	
Contribution from Eurocontrol to be recog	81.733.361	61.164.500 (1)	74,8%
Contributions from other Members to be r	67.354.742	59.893.738 (2)	88,9%
Other sources of contribution and revenue	0	0	
Budget surplus previous year	0	0	
TOTAL REVENUE	**149.088.103**	**121.058.238**	81,2%

(1) not yet validated
(2) including EUR 6.552.469 of in-kind contributions to be validated

Founding Members

3.3.5.2 Annex I of the SESAR JU Budget – In Kind Expenses SESAR 2020

In Kind Expenses SESAR 2020

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 SJU	149.088.103	121.058.238	81,2%
1. Studies/Development conducted by the SJU	0		
2. Studies/Development conducted by Eurocontrol	81.733.361	61.164.500	74,8%
3. Studies/Development conducted by other Members	67.354.742	59.893.738	88,9%
TOTAL EXPENDITURE	149.088.103	121.058.238	81,2%
TOTAL REVENUE		121.058.238	
BUDGET SURPLUS		0	

3.3.5.3 In-kind contributions of the SESAR JU Members other than the Union

During 2019, we assessed the in-kind contributions of the SESAR JU members other than the Union for the second reporting period (covering activities performed in 2018) for an amount of EUR 122.211.173 (out of which EUR 53.341.270 was validated and EUR 68.869.904 are still to be validated[54]). For the reporting period 1 and 2, EUR 167.178.813 is validated and an amount of EUR 69.858.904 is still on validation process. This validation is subject to the submission of the Certificates for the valuation of IKOP certifying the actual costs incurred from the starting date of the H2020-SESAR-2015-2 projects until the end of 2018:

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[54] This validation is subject to the submission of the Certificates for the valuation of IKOP certifying the actual costs incurred in 2018

MEMBERS	Total Net IKOP EUR (Total for SESAR2020) (a)	Total Net IKOP EUR (Total for Wave 1) (b)	Reporting Period 1 Net in-kind contribution validated 2018 (1)	Reporting Period 1 Net in-kind contribution to be validated 2018 (2)	Reporting Period 2 Net in-kind contribution validated RP2 2019 (3)	Reporting Period 1 Net in-kind contribution validated 2019 (4)	Reporting Period 1 Net in-kind contribution still to be validated 2019 (5)=(2)-(4)	Reporting period 2 Net in-kind contribution to be validated (6)	Total Net in-kind contribution still to be validated (7)=(5)+(6)	Total Net in-kind contribution validated (8)=(1)+(3)+(4)	% Execution % Total for Wave 1 (9)=(7)+(8)/(b)	% Total for SESAR2020 (10)=(7)+(8)/(a)
AIRBUS	25,093,735	16,393,735	8,456,750	513,387			513,387	6,514,272	7,027,659	8,456,750	94.45%	61.71%
AT-ONE Consortium	11,867,806	11,867,807	2,182,055		2,462,078		0		0	4,644,134	39.13%	39.13%
B4 Consortium	1,985,379	1,366,904	191,414	56,689	624,579	56,689	0	11,886	11,886	815,993	60.57%	41.70%
COOPANS Consortium	8,676,061	6,354,738	1,488,668		1,851,508		0		0	3,340,175	52.56%	38.50%
DASSAULT Aviation	4,956,639	2,751,376	196,712		295,271		0		0	491,982	17.88%	9.93%
DFS	7,810,987	7,810,986	2,770,809		3,066,617		0		0	5,837,426	74.73%	74.73%
DSNA	9,190,202	6,301,278	2,027,338		2,026,127		0	80,888	80,888	4,053,465	65.61%	44.99%
ENAIRE	15,617,352	8,717,352	2,648,178		2,501,744		0		0	5,149,922	59.08%	32.98%
ENAV	7,499,310	7,499,310	1,236,711		1,479,624		0		0	2,716,335	36.22%	36.22%
FREQUENTIS Consortium	6,410,132	4,357,957	808,991	152,480	1,080,775		152,480	197,346	349,825	1,889,766	51.39%	34.94%
HONEYWELL AEROSPACE	14,546,257	11,576,300	3,021,431		3,284,206		0		0	6,305,637	54.47%	43.35%
INDRA	19,878,000	4,306,900	4,066,800		5,668,406		0		0	9,735,207	226.04%	48.97%
LEONARDO	45,835,829	31,966,497	6,671,150		8,608,064		0		0	15,279,214	47.80%	33.33%
NATMIG Consortium	9,960,423	6,507,920	2,050,535		1,990,565		0		0	4,041,100	62.10%	40.57%
NATS	8,708,327	6,151,563	1,405,703		1,829,382		0	121,424	121,424	3,235,085	54.56%	38.54%
SEAC2020 Consortium	3,263,000	2,237,680		323,133			323,133	441,429	764,562	0	34.17%	23.43%
SKYGUIDE	1,373,305	855,302	263,677		374,675		0		0	638,352	74.63%	46.48%
THALES AVS	32,713,185	21,263,570	8,052,589		7,434,047		0		0	15,486,636	72.83%	47.34%
THALES LAS	71,986,475	45,287,873	6,695,308	731,310	8,763,602	731,310	0	338,159	338,159	15,458,910	34.88%	21.94%
Total Other Members	307,372,404	203,575,048	54,234,818	1,776,998	53,341,270	787,998	989,000	7,705,404	8,694,404	107,576,088	57.11%	37.83%
EUROCONTROL	433,418,444	215,518,402	59,602,725					61,164,500	61,164,500	59,602,725	56.04%	27.86%
Grand Total	740,790,848	419,093,450	113,837,543	1,776,998	53,341,270	787,998	989,000	68,869,904	69,858,904	167,178,813	56.56%	32.00%

3.3.6   Budget outturn

With the SESAR JU being a multi-annual programme (with a limited life-time and a 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. The provisional budget result for 2019 (i.e. total revenues of EUR 124 777 771 minus EUR 151 504 679 total payments) amounted to a deficit of EUR 26 726 908 (deficit of EUR 26 757 136 for SESAR 2020 and surplus of EUR 30 228 for SESAR 1). The 2019 cumulative surplus that remains within the Joint Undertaking amounts to EUR 50 240 390 (of which EUR 19 550 729 is for SESAR 2020 and EUR 30 689 661 is for SESAR 1):

Founding Members

SESAR 1 + SESAR 2020

all figures in EUR	2019	2018	2017
REVENUE RECEIVED FOR THE YEAR			
Contribution from the European Union SESAR1			79.668.467
Contribution from the European Union SESAR2020	114.136.182	88.184.652	82.853.956
Contribution from Eurocontrol	1.848.266	5.189.144	
Contributions from other Members	2.729.585	2.546.435	0
Other sources of contribution and revenue SESAR1	915.510	1.886.316	
Other sources of contribution and revenue SESAR2020	5.148.227	80.633	
TOTAL REVENUE (1)	**124.777.771**	**97.887.180**	**162.522.424**
TOTAL PAYMENTS MADE FOR THE YEAR			
Staff Expenditure SESAR2020	(5.325.094)	(5.219.663)	
Administrative Expenditure SESAR1	0	(169.470)	
Administrative Expenditure SESAR2020	(2.448.741)	(4.050.475)	
Operating Expenditure SESAR1	(885.282)	(1.670.690)	(82.423.704)
Operating Expenditure SESAR2020	(142.845.562)	(67.515.373)	(62.361.177)
TOTAL EXPENDITURE (2)	**(151.504.679)**	**(78.625.670)**	**(144.784.880,80)**
BUDGET SURPLUS of the year (3)=(1)-(2) SESAR1	*30.228*	*46.157*	*(2.755.236)*
BUDGET SURPLUS of the year (3)=(1)-(2) SESAR2020	*(26.757.136)*	*19.215.353*	*20.492.779*
Total Budget Surplus previous year (4) SESAR1	**30.659.434**	**30.613.277**	**33.368.513**
Total Budget Surplus previous year (4) SESAR2020	**46.307.865**	**27.092.512**	**6.599.732**
NEW TOTAL BUDGET SURPLUS (5)=(3)+(4) SESAR1	*30.689.661*	*30.659.434*	*30.613.277*
NEW TOTAL BUDGET SURPLUS (6)=(3)+(4) SESAR2020	*19.550.729*	*46.307.865*	*27.092.511,57*
TOTAL BUDGET OUTTURN (7)=(5)+(6)	**50.240.390**	**76.967.299**	**57.705.789**

SESAR 1

all figures in EUR	2019	2018	2017
REVENUE RECEIVED FOR THE YEAR			
Contribution from the European Union SESAR1			79.668.467
Contribution from Eurocontrol			
Contributions from other Members			
Other sources of contribution and revenue	915.510	1.886.316	
TOTAL REVENUE (1)	**915.510**	**1.886.316**	**79.668.467**
TOTAL PAYMENTS MADE FOR THE YEAR			
Staff Expenditure SESAR1			
Administrative Expenditure SESAR1		(169.470)	
Operating Expenditure SESAR1	(885.282)	(1.670.690)	(82.423.704)
TOTAL EXPENDITURE (2)	**(885.282,26)**	**(1.840.159,63)**	**(82.423.703,50)**
BUDGET SURPLUS of the year (3)=(1)-(2) SESAR1	*30.228*	*46.157*	*(2.755.236)*
Total Budget Surplus previous year (4) SESAR1 **Total Budget Surplus previous year (4) SESAR2020**	**30.659.434**	**30.613.277**	**33.368.513**
NEW TOTAL BUDGET SURPLUS (5)=(3)+(4) SESAR1	*30.689.661*	*30.659.434*	*30.613.277*

SESAR 2020

all figures in EUR	2019	2018	2017
REVENUE RECEIVED FOR THE YEAR			
Contribution from the European Union SESAR2020	114.136.182	88.184.652	82.853.956
Contribution from Eurocontrol	1.848.266	5.189.144	
Contributions from other Members	2.729.585	2.546.435	
Other sources of contribution and revenue	5.148.227	80.633	
TOTAL REVENUE (1)	**123.862.261**	**96.000.864**	**82.853.956**
TOTAL PAYMENTS MADE FOR THE YEAR			
Staff Expenditure SESAR2020	(5.325.094)	(5.219.663)	(4.748.615)
Administrative Expenditure SESAR2020	(2.448.741)	(4.050.475)	(1.341.363)
Operating Expenditure SESAR2020	(142.845.562)	(67.515.373)	(56.271.199)
TOTAL EXPENDITURE (2)	**(150.619.396,75)**	**(76.785.510)**	**(62.361.177,30)**
BUDGET SURPLUS of the year (3)=(1)-(2) SESAR2020	***(26.757.136)***	***19.215.353***	***20.492.779***
Total Budget Surplus previous year (4) SESAR2020	**46.307.865**	**27.092.512**	**6.599.732**
NEW TOTAL BUDGET SURPLUS (5)=(3)+(4) SESAR2020	***19.550.729***	***46.307.865***	***27.092.512***

Budget outturn	N-3*(2017)	N-2*(2018)	N-1*(2019)
Reserve from the previous years' surplus (+)	39 968 246	57 705 789	76 967 299
Revenue actually received (+)	162 522 424	97 887 180	124 777 771
Payments made (-)	(144 784 881)	(78 625 670)	(151 504 679)
Carryover of appropriations (-)			
Cancellation of appropriations carried over (+)			
Adjustment for carryover of assigned revenue appropriations from previous year (+)			

Exchange rate differences (+/-)			
Adjustment for negative balance from previous year (-)			
TOTAL	57 705 789	76 967 299	50 240 390

*N – the year covered by the programming document drafted in N-1 (as per definition art. 32)

Table 10: Budget outturn and cancellation of appropriations

3.3.7 Budget implementation allocation per Area of Operation

The figure below indicates the commitments budget allocation per Area of Operation (total: EUR 147 659 809):

Budget implementation 2019 (Commitments) allocated per Area of operation
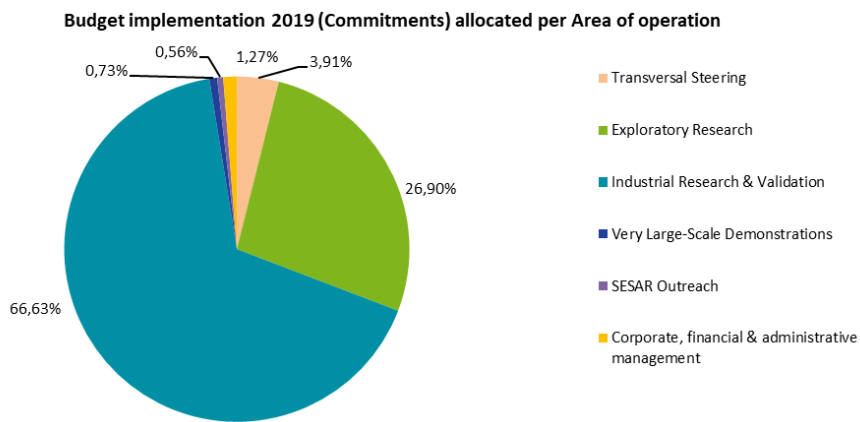
Figure 21: The 2019 Budget allocation per Area of Operation (commitments)

The figure below indicates the payments budget allocation per Area of Operation (total: EUR 151 604 679):

Budget implementation 2019 (Payments) allocated per Area of operation
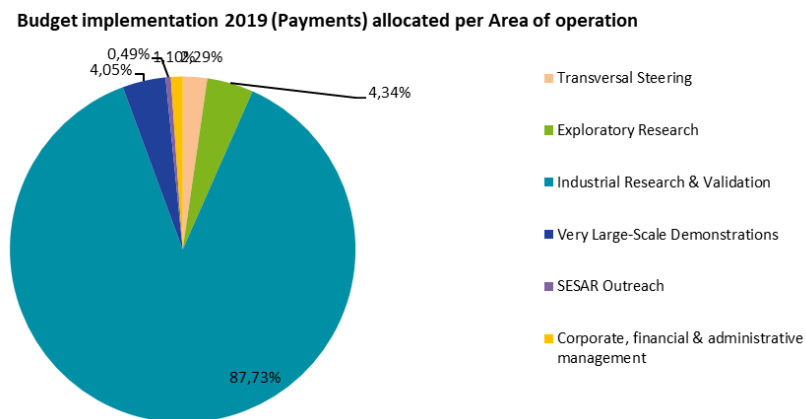
Figure 22: The 2019 Budget allocation per Area of Operation (payments)

3.4   Delegation and sub-delegation

At the SESAR JU, both Delegation and Sub-delegation of Authority are in place. In 2019, the Executive Director has established an annual Delegation of Authority providing Delegation (AOD) to the Deputy Executive Director and a Sub-delegation (AOSD) to the Chief Administration Affairs.

This delegation states the conditions and any constraints applicable to these delegations as well as the corresponding budget lines related to the staff, administrative and operating expenditure. The delegation documents are signed by both parties.

In the course of 2019, two half-yearly reports based on a chronological list of payments from ABAC were submitted by the AOD/SD to the AO and checked by the Internal Audit Capability. Neither report contains any issues or remarks.

3.5   Human Resources (HR) management

Main activities in the field of HR are explained in sub-section 2.6.3. Furthermore, the Administrative Board adopted implementing rules, the list of which appears in table 6 above.

The Staff Establishment Plan appears in Annex IV. Based on this Staff Establishment Plan (and including in addition three Seconded National Experts), at the end of 2019 the benchmarking result is the following:

Job Type (sub) category	2018 (%)	2019 (%)
Administrative Support and Coordination	*29,29%*	*30,00%*
Administrative Support	17,38%	15,71%
Coordination	11,90%	14,29%
Operational	*61,67%*	*59,29%*
General operational	29,29%	29,29%
Programme management	17,86%	15,48%
Top-level operational coordination	10,71%	10,71%
Evaluation & Impact assessment	3,81%	3,81%
Neutral	*9,05%*	*10,71%*
Finance and Control	9,05%	10,71%
Lingustics	0,00%	0,00%

Table 11: Benchmarking on human resources

The slight difference observed for job type categories 'Administrative Support & Coordination' and 'Neutral' is explained by the recruitment of the Chief Financial Officer.

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

FTE allocation (2019) per Area of Operation
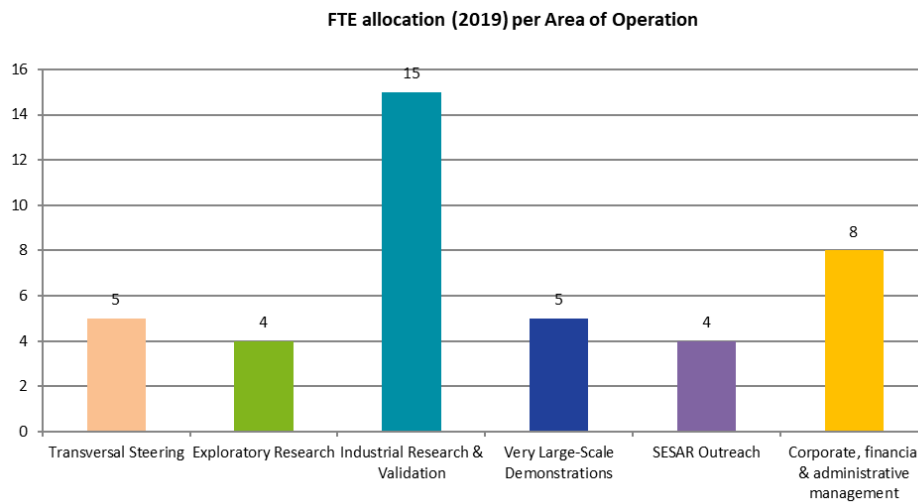
Figure 23: Human resources allocation per Area of Operation

3.6 Strategy for efficiency gains

The European Commission added this item as part of the CAAR guidelines in 2020. However, although measures related to efficiency gains are documented in the Single Programming Document for the period from 2019 to 2021, the SESAR JU had not formalised a strategy for efficiency gains as part of its work programme for 2019, and therefore this section is not applicable for 2019.

3.7 Assessment of audit results during the reporting year

3.7.1 Internal Audit Service (IAS)

3.7.1.1 Strategic risk assessment

In November 2018, the IAS conducted a Strategic Risk Assessment of the SESAR JU. This entails that the IAS analysed the operational, administrative, financial and IT processes of the SESAR JU with the aim of identifying areas of risk and future audit topics. This strategic risk assessment was performed in coordination with the SESAR JU's Internal Audit Capability (IAC) and led to the Strategic Internal Audit Plan (SIAP) 2019-2021, which was published in May 2019.

The main risks identified by the IAS are detailed in Section 5.1.

Based on the results of the risk assessment and considering the overall risk profile of SESAR JU, the IAS intends to perform three audit engagements in the next audit cycle 2019-2021:

- Topic 1: Grant implementation and programme management,
- Topic 2: In-kind contribution validation process,
- Topic 3: HR management.

The IAS identified two reserve audit topics: the implementation of the new internal control framework and data protection (following the entry into force of the new Data Protection Regulation).

3.7.2 Internal Audit Capability (IAC)

In 2019, the IAC performed activities in accordance with the IAC Annual Audit Plan 2019 that was approved by the SESAR JU Administrative Board[55].

These activities focused on assurance audits and consulting engagements. In this context, ad-hoc advice on efficient and effective management and ethics was provided on a regular basis. The IAC conducted a fraud risk assessment, updated the SESAR JU anti-fraud strategy, carried out a consulting engagement on risks and controls related to the use of mobile devices and contributed to the validation of ABAC user authorisations.

Furthermore, the IAC liaised with the IAS, the ECA and all other relevant audit actors, monitored the implementation of several SESAR JU action plans related to past audits and followed-up on the discharge procedure regarding the SESAR JU accounts. Reporting on risks, audits and implementation of recommendations was ensured through regular presentations to the SESAR JU Administrative Board.

A detailed annual report on IAC and general audit activities at the SESAR JU in 2019 will be provided to the SESAR JU Board in Q2 2020.

3.7.3 European Court of Auditors (ECA)

On 14 November 2019, the ECA published the final report on the annual audit of the SESAR JU accounts for the financial year 2018. The report concluded the following:

- the SESAR JU accounts present fairly, in all material respects, the financial position of the SESAR JU, the results of its operations, its cash flows, and the changes in net assets for the year 2018, in accordance with its Financial Regulation and with accounting rules adopted by the Commission's accounting officer,

- the revenue underlying the accounts for the year 2018 is legal and regular in all material respects,

- the payments underlying the accounts for the year 2018 are legal and regular in all material respects.

The Court made observations related to the implementation of the SESAR 1 and SESAR 2020 budget, on internal controls, financial management and performance and followed up previous year's observations. All items were addressed by the SESAR JU.

The full report including the reply of the SESAR JU can be found on the ECA website (https://www.eca.europa.eu/en/Pages/DocItem.aspx?did={7DB1873E-552A-42A7-9746-1777B2D045E9}).

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[55] ADB(D)03-2019 Approval of the IAC Annual Audit Plan 2019

3.8   a. Follow-up of recommendations and action plans for audits

In 2019, no new audit recommendations were issued.

The SESAR JU worked on the implementation of three previous open recommendations related to the audit on Coordination with the Common Implementation Centre (CIC)[56] and implementation of CIC tools and services performed by the IAS. By the end of 2019, these recommendations were submitted for review to the IAS meaning the SESAR JU considers that the action plan related to these recommendations is now implemented.

In December 2019, the SESAR JU has no other open recommendations. All previous audit recommendations stemming from the IAS, the ECA and the European Commission have either been formally closed or have been submitted for closure.

3.9   b. Follow up of recommendations issued following investigations by OLAF

The SESAR JU was not subject to an investigation led by OLAF in 2019. The SESAR JU uses the following indicators to report on OLAF cases:

- Number of files sent to OLAF for investigation in 2019: Zero;
- Time elapsed between receipt by staff or management of first information on alleged internal fraud and transmission to OLAF: not applicable;
- Time elapsed between OLAF requests for information and date when information is provided to OLAF: not applicable;
- Time elapsed between receipt of an OLAF report and the decision on recovery or disciplinary sanctions by the SESAR JU: not applicable.

There are no follow-up actions taken to implement OLAF recommendations from previous years. The SESAR JU has never been subject to an OLAF investigation.

3.10 Follow-up of observations from the discharge authority

3.10.1 Discharge financial year 2017

In March 2019[57], the European Parliament granted discharge to the SESAR JU in respect of the implementation of the budget for the financial year 2017 and approved the closure of the accounts of the SESAR JU for the financial year 2017.

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[56] Under the SESAR JU Regulation, the SESAR JU receives the Union financial contribution from the H2020 Framework Programme to implement the SESAR 2020 Work Programme via calls for proposals. Horizon 2020 (H2020) is directly managed by Commission Directorates-General, Executive Agencies and other implementing bodies such as Joint Undertakings. In order to ensure that they apply the H2020 legislation consistently, the Commission created the Common Implementation Centre (CIC), administratively part of DG RTD, which is in charge of providing centralised support in the following areas: legal advice, ex-post audits, information technology systems and operations, business processes and programme information and data.

[57] Observations made by the European Parliament in its decision of 26 March 2019 on discharge in respect of the implementation of the budget of the SESAR Joint Undertaking for the financial year 2017 (2018/2212(DEC) P8_TA-PROV(2019)0293

Founding Members

This decision was preceded by a hearing session organised by the European Parliament in November 2018. The objective of the hearing was to exchange views with the representatives of Joint Undertakings, in the presence of the Member of the Court of Auditors responsible, Ildikó Gáll-Pelcz.

In its resolution, the European Parliament made observations related to the SESAR JU in terms of budget and financial management (implementation rates for SESAR 1 and SESAR 2020); the multiannual budget implementation under the Seventh Framework Programme, TEN-T and H2020; performance (Key Performance Indicators, policy and operational objectives, the publication by SESAR of the roadmap to ensure safe and secure drone operations across Europe, the management cost ratio, the leverage effect, involvement of stakeholders); procurement and recruitment procedures; prevention and management of conflicts of interests and transparency; internal control (ex-ante control procedures, financial control processes); internal audits (ex-post audits, IAS audits) and other issues (Final Evaluation on SESAR 1 Programme, special report of the European Court of Auditors on the Single European Sky Initiative).

Following the discharge report, the SESAR JU provided a written reply[58] to inform the Parliament on how the SESAR JU addressed the observations made in the context of the discharge for the financial year 2017.

The majority of the replies to the Parliament consisted of further clarifications or details regarding the context of observations. Additionally, the SESAR JU provided details on the status of actions undertaken to address previous audit and evaluation recommendations and on how the leverage of the SESAR JU will be reported.

Finally, the SESAR JU informed the Parliament on the steps taken to address Parliament's concerns in terms of recent departure of key finance staff and the overload of work in the finance department. The SESAR JU notably appointed a new Head of the Budget and Finance team, recruited a Chief Financial Officer and an additional Finance Officer and Finance Assistant. Additionally, a new budget procedure was set up, which led to a timely preparation of the detailed budget. These actions were acknowledged by the Parliament in the context of the discharge in respect of the implementation of the budget for the financial year 2018[59].

3.10.2 Discharge financial year 2018

In May 2020[60], the European Parliament granted discharge to the SESAR JU in respect of the implementation of the budget for the financial year 2018 and approved the closure of the accounts of the SESAR JU for the financial year 2018.

In its resolution, the European Parliament made observations regarding budget and financial management; the multiannual budget implementation under the Seventh Framework Programme, TEN-T and Horizon 2020; performance (Key Performance Indicators in 2018, the achievement of policy and operational objectives, the management cost ratio, collaboration and synergies); procurement and recruitment procedures; internal control (ex ante control procedures, error rate) and internal

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[58] Letter sent by the ED with reference D/19/589
[59] European Parliament decision of 13 May 2020 on discharge in respect of the implementation of the budget of the SESAR Joint Undertaking for the financial year 2018 (2019/2100(DEC))
[60] European Parliament decision of 13 May 2020 on discharge in respect of the implementation of the budget of the SESAR Joint Undertaking for the financial year 2018 (2019/2100(DEC))

audits (follow up of recommendations from the IAS, IAC and risk management). Additionally, observations from the Transport and Tourism committee were included.

The observations of the Parliament will be formally acknowledged by the SESAR JU. A written reply will be send to inform the Parliament on the measures that the SESAR Joint Undertaking intends to adopt to address the observations made by the European Parliament in the context of the discharge 2018.

3.11 Environment management

The European Commission added this item as part of the CAAR guidelines in 2020.

However, the SESAR JU had not formalised an environment management strategy as part of its Single Programming Document for the period from 2019 to 2021 nor of its work programme for 2019, and therefore this section is not applicable for 2019.

3.12 Assessment by management

Based on the control procedures performed by staff of the SESAR JU, a positive conclusion on the legality and regularity of transactions can be drawn.

This conclusion takes into consideration the need for SESAR JU 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 Internal Control Framework and to ensure the achievement of objectives in its annual work programme.

Overall budget implementation rate

As a result of year budget monitoring throughout the year, budget execution rate is at 104.4% for revenue commitment appropriation execution and at 91.7% for expenditure commitment appropriation (see also Subsections 3.3.2.1 and 3.3.2.2).

Legality and regularity

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, authorisation and payment).

Procurement procedures

Eight procedures (including four high value and four low-value procedures) were run and all completed in 2019, in addition to the ones launched in previous years and concluded in 2019. More details can be found in Subsection 2.6.5.

Registration of exceptions – report

The SESAR JU has established an exceptions and non-compliance events management process, authorised in 2018 within the SESAR JU Quality Management System through a decision of the

Executive Director[61]. This process includes an "exceptions and non-compliance events register" to manage and monitor possible deviations which are not initially foreseen by the procedures submitted to the Authorising Officer with a justification for endorsement. If such control-overrides or deviations are approved before action is taken (ex-ante), they are called "**exceptions**". If they are detected after action was taken (ex post), they are "**non-compliance events**". The non-compliance events might constitute a breach of existing regulatory and/or contractual provisions, can correspond to errors, flaws or even fraud. Non-compliance events reflect a deficiency in existing controls. They cannot be authorised (as in the ex ante cases), but should be reported by the appropriate management level.

As part of the above mentioned process, over 2019, the SESAR JU recorded:

- three non-compliance events (i.e. one procurement related (contract duration), one finance related (budget commitment) and one HR related (internal process definition), and

- two exceptions (i.e. one finance related (payment) and one related to H2020 implementation (final proposal content)).

The exceptions and non-compliance events register is available on request and is, for instance, consulted by the European Court Auditors during audits.

Audit results and recommendations

In 2019, no critical recommendations were issued or closed and on 31 January 2019, no critical recommendations were open. In 2019, there were no recommendations issued by the IAS. Moreover, all previous audit recommendations stemming from the IAS, the ECA and EC have either been formally closed or have been submitted for closure. See Sections 3.8 and 3.9 a above for further detail.

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[61] ED decision 647 of the 23 March 2018

4 Part IIb. External evaluations

The SESAR JU was subject to two evaluations in 2017. One concerned the closure of the SESAR 1 programme (final evaluation of SESAR 1: 2007-2016), while the second focused on the ongoing research activities under the SESAR 2020 programme (interim evaluation of SESAR 2020: 2014-2020).

The SESAR JU management considers that the action plan related to both evaluations is implemented except for one recommendation which has been put on hold as it is subject to the next MFF perspectives.

In 2019, the SESAR JU was not subject to an external evaluation.

Founding Members

5 Part III. Assessment of the effectiveness of the internal control systems

5.1 Risk management

5.1.1 Assessment of corporate risks at the end of 2019

In 2019, the SESAR JU executed its risk management process implementing the SESAR JU Risk Management Policy (SESAR JU/ED/613). This year, as other initiatives (Airspace Architecture Study and its Transition Plan, ATM Master Plan update campaign) already entailed comprehensive risk assessment and reviews in the course of the first semester (primarily linked to the execution of the European ATM Master Plan), the SESAR JU held one risk management workshop in October, instead of the two usually foreseen by the policy.

According to the risk management process, the SESAR JU risk management focuses on critical risks affecting the achievement of the SESAR JU objectives defined in the SPD. A risk should be considered significant if it falls within at least one of the following impact categories:

- jeopardises the achievement of strategic goals or effective implementation of the mandate of SESAR JU,

- causes serious damage to SESAR JU's stakeholders or partners,

- results in critical intervention at political level (e.g. Council/Parliament) regarding the SESAR JU'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.

At the end of 2019, the corporate risks and related response actions are:

Risk No	Risk description	Consequences and impacts	Affected 2019 objectives	Risk owner	Summary of response actions
1	R&D activities do not deliver solutions allowing to reach expected ATM performance		- Alignment of Level 2 and level 1 of the Master Plan - Master Plan Level 3 implementation - IR Wave 1 projects delivery of results	SESAR JU	- ATM Master Plan update to identify clear priorities for future investments with a focus on solutions that hold the potential to provide a step-chance in ATM performance - Launch Wave 2 projects in 2019 (SPD 2019)
2	The SESAR JU may not be able to take up new	- Endangers the realisation of objectives	Preparation of new cooperative	SESAR JU	- Re-assess need for support contracts to get additional expertise

	challenges due to limited HR capabilities	outlined in the European ATM Master Plan	arrangement with actors in Aviation Preparation for the future ATM partnership		during peaks of workload not to endanger the realisation of core business activities
3	The BREXIT may have an impact on SESAR JU objectives	- Endangers the realisation of objectives outlined in the European ATM Master Plan - Results in critical intervention at political level (Commission, Council, Parliament) regarding SESAR JU's performance	Potentially all	SESAR JU	- Close liaison with Commission services to implement any necessary measures
4	IOP solution supporting the PCP and developed in SESAR 2020 may not be delivered on time for deployment	- European modernization is not aligned with other global plans - Lack of consideration of common standards may cause reworking resulting in delays in deployment and increased development costs	Delivery of Wave 1 project results (sol candidate SESAR Solution PJ.18-02b)	SESAR JU	- Continuous close monitoring of the progress by a PC dedicated Decision Team (supported by an Analysis Team at technical level); this set-up established at end of SESAR 1 to secure recovery towards PCP objective will continue its operations until final solution delivery defining specific actions to put in place when necessary
5	Risk on the Members' contribution to running costs	Contrary to other JTIs, the amount of the contribution of non-EU members to the running costs of the SESAR JU is not fixed in the basic act. This amount is defined as a percentage of the in-kind contribution in the Membership Agreement. As a consequence, if the non-EU members' in-kind contribution is lower than planned, their contribution to SESAR JU's running costs will be lower too.	- Monitor efficiency and effectiveness of SESAR JU's financial activities - Carry out payments to Members and beneficiaries - Implement the calls and grants management framework	SESAR JU	- Maintain a reserve in the SESAR JU budget (estimate of the reserve amount in 2019: EUR 9.5 million, of which EUR 0.5 million within Title I, EUR 2.2 million within Title II and EUR 6.8 million within Title III) - Monitor the effective contribution of non-EU members to the running costs of the SESAR JU regularly and mobilise funds from the reserve as required

| | | In 2019, the exposure is estimated to be up to EUR 6 million. The impact of a lower contribution to running costs would be that the SESAR JU may lack financial resources to cover its planned expenditure and not be in a position to fulfil all its legal commitments until the end of 2024.On the contrary, Title I and II expenditure is in most cases related to commitments with low adaptability (e.g. wages, rental fees, ICT system…) In addition, the SESAR JU may have to face unexpected expenditure in Title III (for a maximum value of EUR 3.5 million). The total maximum risk exposure is EUR 9.5 million. | | | |

<p align="center">Table 12: SESAR JU corporate risks and response plan summary at the end of 2019</p>

5.1.2   Assessment of risk performed by the IAS

In May 2019, the IAS published the results of the Strategic Risk Assessment that the IAS performed in 2018 with the aim of identifying areas of risk and future audit topics. This Strategic Risk Assessment led to the Strategic Internal Audit Plan (SIAP) 2019-2021 (see Subsection 3.8.1.1).

The IAS concluded that the most significant risks relate to the following three topics:

- Grant implementation and programme management: The SESAR JU's activities follow the standard H2020 grant management cycle from the preparation and launch of calls for proposals, via project implementation to closure. In its previous Strategic Internal Audit Plan, the IAS covered the risks of the initial phase of the grant management process. In the current risk assessment exercise, the IAS singled out the risks related to the grant implementation phase and programme management and will conduct an audit in this field.

- The in-kind contribution validation process: The majority of contributions from SESAR JU's private members and Eurocontrol are in-kind contributions. Taking into account the high amounts involved and the complexity and importance of the validation process, the IAS will conduct an audit on the in-kind contribution validation process.

- HR management: The staffing plan of the SESAR JU consists of 39 temporary and contract agent posts. In addition, there are staff members seconded from Eurocontrol, from industry members

and seconded national experts from Member State authorities. The combination of 'traditional' HR related risks (HR planning and allocation, recruitment and career development) with the unique challenge of workforce that is subject to two different regulations (EU and Eurocontrol), led the IAS to plan an audit on HR management.

The IAS also identified two additional areas of risks that might be audited in the coming years.

- The new internal control framework: The SESAR JU completed the transition to the new internal control framework at the end of 2018. This entails a shift of focus from compliance towards an assessment of the effectiveness and efficiency of the control system which might result in risks to the organisation.

- The Internal Data Protection Regulation (IDPR): The IDPR lays down rules relating to the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies. If roles, responsibilities and processes of staff working with personal data are unclear or not defined or do not match the new data protection regulation, this may lead to personal data not being properly managed and to litigation and financial claims. This is a cross-cutting risk which applies to all EU Institutions and Bodies. In the case of the JUs most of the grant related personal data is managed by the Common Support Centre (CSC). There is therefore a joint ownership of the data and consequently of the risk.

Finally, the IAS identified a number of risks, which were brought to the attention of management even though these will not be covered by internal audit work of the IAS. The SESAR JU has already initiated actions to address these risks in 2019 and will continue to work on mitigating controls in 2020.

- An inherent risk for the SESAR JU is the uncertainty derived from the fact that the next framework programme for research and innovation for the period 2021-2027, Horizon Europe, has not yet been adopted by the Council and the European Parliament. It is therefore unknown whether Horizon Europe will include a third generation of JUs. This entails a major factor of uncertainty for the JU and bears important risks to its continued existence. As the proposal and adoption of Horizon Europe falls outside of the JU's remit, this was considered as a non-auditable topic.

- The absence of an updated business continuity plan and lack of a tested disaster recovery plan increases SESAR JU's business continuity risk and should be addressed by SESAR JU's management. However, taking into account the higher priority of the core business of the JU and the limited IAS resources, this risk will not be audited.

- In the area of ICT, the IAS identified two risks which are worth highlighting. First the risk that the lack of an IT strategy may lead to non-alignment between business and IT, and a sub-optimal value from projects and services portfolio. Second, the risk that SESAR's supplier management could lead to a lack of control of IT suppliers which could result in paying prices for IT services above the market prices. However, taking into account the higher priority of the other audit topics and the IAS' limited IT auditing resources, these risks will not be audited.

5.1.3   Fraud risk assessment

In the context of the update of the anti-fraud strategy and action plan, the IAC carried out a fraud risk assessment in 2019 to ensure alignment of the strategy with the current risks.

This fraud risk assessment involved three steps: identification of the risks of fraud, assessment of the identified risks and prioritisation of the risks.

Founding Members

Risk identification: A list of 42 potential fraud related risks were identified. This list covered non-financial fraud by taking into account the risks of serious damage to the image and reputation of the SESAR JU, the Commission and the European Union as a whole. Furthermore, it included abuse of law, corruption, fraud, money laundering, fraudulent behaviour in procurements and grants, conflicts of interests, fraudulent behaviour in recruitment and any behaviour defined as illegal.

Risk assessment: The assessment of the listed risks was performed in two steps. Firstly, a questionnaire including the list of risks was distributed to all SESAR JU staff members (including management, excluding contractors). Staff members were asked to provide an opinion on each of these risks in terms of likelihood. In other words, their opinion on which risks are likely to materialise at the SESAR JU. The possible answers ranked from 'probably not', 'it is reasonably possible', 'it is probable', 'it is highly probable' to 'I have no idea'. A scale of 4 was used to score the answers. A total of 35 staff members replied to the survey.

Consequently, the results of this assessment were discussed in a workshop with SESAR JU management. During this second stage, the 'impact/likelihood' approach was used to determine the significance of the risks. In other terms, management was asked to assess the highest risks identified via the staff questionnaire, both in terms of impact and likelihood. In doing this, the fraud risks were confronted with the internal controls that are currently implemented to check whether and to what extent the internal procedures mitigate the identified risks.

The most significant risks were consequently documented in a risk register.

It was observed that some risks scored high during the risk assessment exercises of both 2016 and 2020. These risks are all related to external fraud and can be summarised as manipulation of grants and procurement by third parties (ex. double funding, false or inflated time sheets and defective pricing). It is important to note that some of the internal sources of fraud such as theft or leak of intangible assets or misuse of access rights scored significantly lower in 2019 compared to 2016.

In conclusion, in very general terms, taking into account the overall context and existing controls, the SESAR JU believes that the risk of significant undetected fraud is limited. In this context, it has to be noted that the SESAR JU has never been subject to an OLAF investigation.

5.1.4   Risk identification related to the use of mobile devices at the SESAR JU

In Q4 2019, the IAC performed a consulting engagement with the aim to support management's efforts to manage the risks associated with the use of mobile devices. In this context, a risk identification exercise was carried out which led to an overview of risks in terms of policies, data protection, physical security, operating systems, data storage, network connections and applications.

In Q1 2020, a risk assessment exercise is planned by SESAR JU management with the objective to assess and prioritise these risks and to discuss the controls that can be used to mitigate the highest risks to an acceptable level. Critical risks will be included in the corporate risk register in 2020.

5.2   Effectiveness of Internal Control Systems

The Corporate Management Team reviews, assesses and monitors its internal control according to the Internal Control Framework introduced by the European Commission in 2017. This is done on a yearly basis, by assessing each of the 50 characteristics of the 17 principles across the five components of the

Internal Control Framework[62], materialised with a rating (3 = full compliance; 2 = partial compliance requiring improvement; 1 = non-compliance requiring action plan).

The figure below summarises this assessment for the 17 principles for the year 2019:

Figure 24: Assessment by the SESAR JU management team against the Internal Control Framework at the end of 2019

As shown in the figure, the SESAR JU implements 15 out of the 17 Principles fully and two others partly.

For the Principle 10 'Selects and develops control activities', the SESAR JU implements all control activities which are required from the key regulations and EC guidance (Financial Regulation and FFR, SESAR JU Regulation, Staff Regulation etc.); these control activities are embedded in the business processes that form part of the Quality Management System. However, a control strategy has not been formalised as such.

For the Principle 16 'Conducts ongoing and/or separate assessments', the SESAR JU relies on building blocks which are the Quality Management System (including all key business processes), the Financial Matrix, the Information and Document Management System, the exception register and the data protection register. Through these building blocks, the SESAR JU ensures control of its activities and registration of deficiencies when required. However, due to the limited size of the SESAR JU, no systematic separate assessment of internal control activities is conducted.

A complete report on the assessment of the implementation of the Internal Control Framework is available in annex VII.

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[62] The Internal Control Framework was published by the European Commission in 2017: Communication to the Commission from Commissioner Oettinger with reference C(2017) 2373 final on the revision of the Internal Control Framework

5.3   Conclusions of assessment of internal control systems

Cost and benefits of controls (report on the balance between effectiveness (including benefits), efficiency and economy of controls): the European Commission added this requirement as part of the CAAR guidelines in 2020. However, in order to implement procedures and data sets to calculate the cost and benefit of control, this requirement will be fulfilled as from the Consolidated Annual Activity Report for the year 2020.

5.4   Statement of the Director in charge of risk management and internal control

I, the undersigned,

Manager in charge of risk management and internal control within (agency),

In my capacity as Manager in charge of risk management and internal control, I declare that in accordance with (agency)'s Internal Control Framework, I have reported my advice and recommendations on the overall state of internal control in the Agency to the Executive Director.

I hereby certify that the information provided in the present Consolidated Annual Activity Report and in its annexes is, to the best of my knowledge, accurate, reliable and complete.

Place Brussels date 30 June 2020

Peter Hotham

Deputy Executive Director

SESAR Joint Undertaking

5.5   Project audits

The Research and Innovation Framework Programmes main indicators on legality and regularity are:

- **the representative detected error rate**, based on errors detected by ex-post audits on a Common Representative Sample (CRS) of cost claims across the research and innovation family.

- **the cumulative residual error rate**, is the extrapolated level of error after corrective measures have been implemented by the Commission services following the audits, accumulated on a multi-annual basis.

Due to its multi-annual nature, the effectiveness of the control strategy of the research and innovation Directorates-General can only be fully measured and assessed in the final stages of the Framework Programme, once the ex-post control strategy has been fully implemented and systematic errors have been detected and corrected.

For Horizon 2020, the objective is to obtain a cumulative residual error rate within a range of between 2-5 % aiming to be as close as possible to 2%, without necessarily expecting it to be lower than 2%.

Progress against these objectives is assessed annually based on the results of the implementation of the ex-post audit strategy and taking into account the frequency and importance of the detected errors along with cost-benefit considerations regarding the effort and resources needed to detect and correct the errors.

5.5.1   Results of the Horizon 2020 ex-post audits

Control results for Horizon 2020 are related to audits launched by the CIC's Common Audit Service (CAS).

The error rates for Horizon 2020[63] as of 31 December 2019 are:

- Representative detected error rate**:** 2.78 %[64], expected to rise to 3.30 % taking into account the results of draft audit reports.

- Cumulative residual error rate for the research and innovation Family of DGs: 2.15 % (2.24 % for DG RTD), expected to rise to around 2.31 % (2.40 % for DG RTD) when taking into account the results of the draft audit reports.

The above-presented error rates should be treated with caution not only because of the above-mentioned top-up. Since not all results of the three Common Representative Samples are yet available, the error rate is not fully representative of the expenditure being controlled. Moreover, the nature of expenditure in the first years of the programme may not be totally representative of the expenditure across the whole period.

Since Horizon 2020 is a multi-annual programme, the error rates, and especially the residual error rate, should be considered within a time perspective. Specifically, the cleansing effect of audits will tend to increase the difference between the representative detected error rate and the cumulative residual error rate, with the latter finishing at a lower value.

As was the case last year, there is evidence that the simplifications introduced in Horizon 2020, along with the ever-increasing experience acquired by the major beneficiaries, affect positively the number

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[63] The Horizon 2020 audit campaign started in 2016. At this stage, three Common Representative Samples with a total of 467 expected results have been selected. By the end of 2019, cost claims amounting to EUR 16.2 billion have been submitted by the beneficiaries to the services. The audit coverage for Horizon 2020 is presented in annex 10. In addition to the Common Representative Samples, Common Risk Samples and Additional Samples have also been selected. The total of all samples represents 3245 participations. The audits of 2115 participations were finalised by 31/12/2019 (out of which 962 in 2019). This sampling accommodates special needs of certain stakeholders with regard to audit coverage and selection method. In addition, top-ups, which are participations of selected beneficiaries and which are added to the selected participations, are included in the total participations selected.

[64] Based on the 298 representative results out of the 467 expected in the three CRS.

and level of errors. However, beneficiaries still make errors, sometimes because they lack a thorough understanding of the rules, sometimes because they do not respect them.

In conclusion, DG RTD considers that the 2019 cumulative residual error rate for Horizon 2020 will fall within the target range established in the Financial Statement[65], and therefore a reservation is not necessary for the Horizon 2020 expenditure

5.5.2   Results of the ex-post SESAR-specific audits

In 2018, a snapshot of the population of the core SESAR activities (IR-VLD) was taken on 28 June 2018, on the amounts paid by that cut-off date (total of EUR 33 million) resulting to a sample of 15 participations in 11 beneficiaries and audit coverage of 22%. This sample was complemented by additional 14 participations as top-ups to the above population, as well as five participations in three beneficiaries that topped-up audits under the second Common Representative Sample.

By the 31 December 2019, the CAS finalised audit reports concerning 31 participations in 13 beneficiaries (out of 34 participations in 14 beneficiaries, in total), resulting in a Detected Error Rate of 2.61% with systematic errors of 2.68% and a Residual Error Rate of 1.76%. The SESAR **cumulative residual error rate is 1.61%.**

In 2019, one snapshot of the population was taken on 25 June, on the cost claims received and paid by that cut-off date (total of EUR 118 million) resulting to a sample of 17 participations in 13 beneficiaries and audit coverage of 9%. This sampled population was topped-up with another 10 participations. The audit results of these audits will be available in 2020.

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[65] The legislative financial statement accompanying the Commission's proposal for the Horizon 2020 regulation states: "*The Commission considers therefore that, for research spending under Horizon 2020, a risk of error, on an annual basis, within a range between 2-5% is a realistic objective taking into account the costs of controls, the simplification measures proposed to reduce the complexity of rules and the related inherent risk associated to the reimbursement of costs of the research projects. The ultimate aim for the residual level of error at the closure of the programmes after the financial impact of all audits, corrections and recovery measures will have been taken into account is to achieve a level as close as possible to 2%.*"

6 Part IV. Management assurance

6.1 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 SESAR JU, 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 3.12.

Building block 2 – Register of exceptions:

This assessment is provided in Section 3.12.

Building block 3 – Audit results during the reporting period:

Audit results and recommendations are presented in Sections 3.8, 3.9 a and 3.10.

Section 5.5 presents the results of H2020 ex-post (project) audits. Whilst the audit process for FP7 projects was carried out under responsibility of the SESAR JU, the audit of H2020 cost claims are fully centralised in the Common Audit Service (CAS) of the Common Implementation Centre (CIC)[66].

The European Court of Auditors uses the results of these ex-post audits when performing the annual audit of the SESAR JU accounts. In this context, the European Court of Auditors decided in 2018 to re-perform a sample of these audits in order to establish whether the results can be relied upon[67].

This review revealed weaknesses in the ex-post audit work performed by the CAS. Indeed, the European Court of Auditors concluded in their Annual Report 2018[68] that "*these additional audit procedures revealed weaknesses in documentation, sampling consistency and reporting, as well as in the quality of the audit procedures in some of the files reviewed. For example, ineligible amounts not detected by the auditors due to insufficient testing in their audit, and errors in the calculation of the personnel costs claimed we found. Although, in some cases, the financial impact was not material, in 10 of the 20 audit files sampled, we were not able to rely on the audit conclusions. Therefore, currently we cannot use the results of the Commission's audit work.*"

In that same annual report, the European Court of Auditors requests the Commission for Horizon 2020 to address these observations concerning documentation, sampling consistency and reporting, as well as the quality of the audit procedures.

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[66] Common Audit Service for Horizon 2020 Framework Programme for Research and Innovation expenditure at the European Commission (CAS) hosted by DG RTD

[67] Annual report of the Court of Auditors on the implementation of the budget concerning the financial year 2018, Chapter 5, part 1, paragraphs 5.31-5.40. (https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=50534)

[68] Annual report of the Court of Auditors on the implementation of the budget concerning the financial year 2018, Chapter 5, part 1, paragraphs 5.31-5.40. (https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=50534)

The SESAR JU has understood that (1) the Commission is analysing these observations concerning ex-post audit work and will continue to work closely with the European Court of Auditors in this area and (2) that the Commission acknowledged that in most cases found by the European Court of Auditors, the financial impact was not material.

However, it should be noted that the fact that the European Court of Auditors currently cannot rely on the audit conclusions of the CAS, may also affect the reliability of the assurance provided to the Authorising Officer.

Building block 4 – Internal Control:

The assessment of the SESAR JU's Internal Control Framework is presented in Section 5.2.

6.2 Reservations

There are no reservations with regard to the SESAR JU's activities in 2019.

6.3 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 2019 and the corresponding underlying financial operations (legal and financial commitments). This is also the case for SESAR JU 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 SESAR JU's activities, in line with the principles of economy, efficiency and effectiveness.

7 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.

Understand that the European Court of Auditors is performing a further cycle of reviews in the field of H2020 ex-post audits.

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, 30 June 2020

Florian Guillermet

Executive Director

SESAR Joint Undertaking

8 Annexes

8.1 Annex I. Core business statistics

8.1.1 Annex I.1: Horizon 2020 Scoreboards

The tables below follows the instructions on Annual Activity Reports for Joint Undertakings operating under Horizon 2020:

8.1.1.1 Scoreboard of Horizon 2020 common KPIs

REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[69]	Value in 2018	Value in 2019
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	78 (37.3 %)	91 (32.9 %)[70]
2	SME - Growth and job creation in participating SMEs (turnover of company, number of employees)	Turnover of company Number of employees	N	Not available	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	27	20
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	Number of patent applications: 4 Number of awarded patents: 3	Number of patent applications: 0 Number of awarded patents: 0

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[69] Data not provided by the SESAR JU is provided by beneficiaries through project reporting
[70] Data referring to projects with end date between 2019-2022

5	Number of prototypes testing activities and clinical trials	Number of prototypes, testing (feasibility/demo) activities, clinical trials	N	Prototypes: 259 Feasibility activities: 344 Clinical trials: n/a[71]	Prototypes: 294 Feasibility activities: 431 Clinical trials: n/a[72]
6	Number of joint public-private publications in projects	Number and share of joint public-private publications out of all relevant publications.	N	25[73]	27[74]
7	New products, processes, and methods launched into the market	Number of projects with new innovative products, processes, and methods	N	Innovative products: 15 Innovative processes: 11 Innovative methods: 12[75]	Innovative products: 16 Innovative processes: 19 Innovative methods: 22[76]
8	Time to inform (TTI) all applicants of outcome of evaluation	Number and % of information letters sent to applicants within target (153 days) Average TTI (calendar days) Maximum TTI (calendar days)	Y	N/A	16 (100 %) Average: 91 days Maximum: 91 days

[71] Cumulative amounts referring to 2016-2018
[72] Cumulative amount referring to 2016-2019
[73] Cumulative amount referring to 2016-2018
[74] Cumulative amounts referring to 2016-2019
[75] Cumulative amounts referring to 2016-2018
[76] Cumulative amounts referring to 2016-2019

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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 (8 months)	Y	N/A	12 (75%)
		Average TTG in calendar days			Average: 234
		Maximum TTG in calendar days			Maximum: 382[77]
11	Time to sign (TTS) from successful applicant letter	Number and % of grants signed within target (92 days)	Y	N/A	0 out of 16
		Average TTS in calendar days			Average: 140
		Maximum TTS in calendar days			Maximum: 258[78]
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		100 % on time for pre-financing
		Average number of days for administrative payments			Average number of days for pre-financing: 5[79]

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[77] Data referring to call H2020-SESAR-2019-1 and project AUDIO (H2020-SESAR-2016-2) signed in 2019
[78] Data referring to call H2020-SESAR-2019-1 and project AUDIO (H2020-SESAR-2016-2) signed in 2019;
[79] Data referring to call H2020-SESAR-2019-1 and to project AUDIO from call H2020-SESAR-2016-2

		Number of experts appointed			
13	Vacancy rate (%)	% vacancy rate during the reporting period	Y	5.13 %[80]	2.5 %[81]
14	Budget implementation/execution:	% of CA and PA	Y		
	1. % CA to total budget			83.18 %	91.69 %
	2. % PA to total budget			47.23 %	82.66 %
15	Administrative Budget: Number and % of total of late payments	Number of delayed payments	Y		0 %

Table 13: Scoreboard of Horizon 2020 common KPIs

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[80] Incl. one Financial Assistant AST 3 whose selection was finalised in December 2018 (start date: 01/02/2019)
[81] The contract of the Chief Financial Officer was signed in December 2019, but his starting month was January 2020

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8.1.1.2 Indicators for monitoring cross-cutting issues

REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
16	Number of nationalities in H2020 applicants & beneficiaries	Nationality of Horizon 2020 applicants & beneficiaries (number of)	N	N/A	19
17	Total amount of EU financial contribution by Member State	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	N	Austria: EUR 7 420 921 Belgium: EUR 8 199 467 Bulgaria: EUR 56 300 Croatia: EUR 919 962 Czech Republic: EUR 3 610 800 Denmark: EUR 2 818 248 Finland: EUR 852 516 France: EUR 106 419 457 Germany: EUR 24 926 126 Greece : EUR 170 000 Hungary: EUR 1 093 162 Ireland: EUR 2 483 707 Italy: EUR 35 722 244 Lithuania: EUR 1 380 102 Luxembourg: EUR 72 000 Malta: EUR 185 859 Netherlands: EUR 5 080 422	Austria: EUR 2 326 766 Belgium: EUR 451 721 Croatia: EUR 328 510 Czech Republic: EUR 903 441 Denmark: EUR 458 366 France: EUR 36 517 413 Germany: EUR 5 674 567 Hungary: EUR 740 293 Ireland: EUR 429 679 Italy: EUR 11 967 153 Lithuania: EUR 879 196 Netherlands: EUR 464 601 Poland: EUR 1 987 879 Spain: EUR 14 410 918

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[82] Data not provided by the SESAR JU is provided by beneficiaries through project reporting

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REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
				Poland: EUR 2 550 531 Portugal: EUR 606 800 Slovakia: EUR 1 858 361 Slovenia: EUR 141 543 Spain: EUR 47 422 843 Sweden: EUR 8 446 303 United Kingdom: EUR 19 623 130[83]	Sweden: EUR 3 097 005 United Kingdom: EUR 3 553 069[84]
18	Number of nationalities in H2020 applicants & beneficiaries (associated countries)	Nationality of Horizon 2020 applicants & beneficiaries (number of)	N	N/A	2 (Norway, Switzerland)[85]
19	Total amount of EU financial contribution by associated country	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	N	Iceland: EUR 26 700 Israel: EUR 591 409 Norway: EUR 4 770 520 Serbia: EUR 600 859 Switzerland: EUR 5 560 770 Turkey: EUR 373 125[86]	Norway: EUR 1 545 019 Switzerland: EUR 2 016 023[87]

[83] Cumulative total amount, refers to calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1 and H2020-SESAR-2016-2
[84] Cumulative amount, refers to call H2020-SESAR-2019-1 and project AUDIO from call H2020-SESAR-2016-2
[85] Data refers to call H2020-SESAR-2019-1 and project AUDIO from call H2020-SESAR-2016-2
[86] Cumulative total amounts referring to calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1 and H2020-SESAR-2016-2
[87] Data refers to call H2020-SESAR-2019-1 and project AUDIO from call H2020-SESAR-2016-2

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REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
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	9 %[88]	31 SMEs 5.3 %[89]
21	Percentage of women in H2020 projects	Gender of participants in Horizon 2020 projects	N	N/A	19 %[90]
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	20 %[91]
23	Percentage of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc.	Gender of memberships in advisory groups, panels, etc.	Y	N/A	Not available
24	Share of third-country participants in Horizon 2020	Nationality of Horizon 2020 beneficiaries	N	0	0
25	Percentage of EU financial contribution attributed to third country participants	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	N	0	0

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[88] Cumulative amount referring to calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1 and H2020-SESAR-2016-2

[89] Data referring to call H2020-SESAR-2019-1 and projects AUDIO from call H2020-SESAR-2016-2

[90] Data referring to call H2020-SESAR-2019-1

[91] Data referring to call H2020-SESAR-2019-1

REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
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	Number of IA projects: 14[92] % of IA projects out of all projects: 17.7% IA out of overall EU contribution: 16.6%	Number of IA projects: 2[93] % of IA projects out of all projects: 14 % IA out of overall EU contribution: 4 %
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	100 % (all IA projects are VLD activities)	100 % (all IA projects are VLD activities)
28	Scale of impact of projects (high-technology readiness level)	Number of projects addressing TRL between … (4-6, 5-7)?	Y	45 projects up to TRL 2 or equivalent operational concept maturity level ('ER') 17 projects from TRL 2 to 6 or equivalent operational concept maturity level 14 projects from TRL 6 to 7 or equivalent operational concept maturity level 3 projects address transversal activities, i.e. non-directly TRL or operational concept-related activities	17 projects up to TRL 2 or equivalent operational concept maturity level ('ER') 17 projects from TRL 2 to 6 or equivalent operational concept maturity level 22 projects from TRL 6 to 7 or equivalent operational concept maturity level 3 projects address transversal activities, i.e. non-directly TRL or operational concept-related activities

[92] Cumulative amount referring to calls H2020-SESAR-2015-2 and H2020-SESAR-2016-2
[93] Amount referring to call H2020-SESAR-2019-1 and project AUDIO from H2020-SESAR-2016-2

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REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
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	578 out of 880 (65.7 %) for PRC ER: 92 out of 223 (41.3 %) IR: 374 out of 505 (74 %) VLD: 112 out of 152 (73.9%)[94]	258 out of 346 (76.6%) for PRC IR: 250 out of 333 (75 %) VLD: 8 out of 13 (61.5%)
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	EUR 222 826 790 for PRC out of total EUR 293 984 187 (75 %)	EUR 72 288 758 for PRC out of total EUR 87 751 621 (82.4 %)
31	EU financial contribution for PPP (Art 187)	EU contribution to PPP (Art 187)	Y	EUR 293 984 187[95]	359 627 633 EUR [96]
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 - in-kind contribution already committed by private members in	Y	See indicator #40	See indicator #40

[94] Cumulative amounts referring to calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1 and H2020-SESAR-2016-2
[95] Cumulative amount referring to the signature of grant agreements resulting from the calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1 and H2020-SESAR-2016-2
[96] Cumulative amount referring to the signature of grant agreements resulting from the calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1, H2020-SESAR-2016-2 and H2020-SESAR-2019-1

REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
		project selected for funding - additional activities (i.e. research expenditures/investment of industry in the sector, compared to previous year)			
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		
34	Proposal evaluators by country	Nationality of proposal evaluators	Y	N/A	Greek: 1 Polish: 1 UK: 1 Bulgarian: 1 Austrian: 1 Portuguese: 1 Italian: 1 + SESAR JU staff involved in the evaluation:

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REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
					Spanish: 2
					UK: 1
					Dutch: 1
35	Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	Y	N/A	Higher Education: 3 Research organisation: 1 Public organisation: 1 Other: 2
36	Participation of RTOs and Universities in PPPs	Number of participations of RTOs to funded projects and % of the total Number of participations of Universities to funded projects and % of the total % of budget allocated to RTOs and to Universities		199 (REC) out of 1201 (all entity types) −16.6 % 98 (HES) out of 1201 (all entity types) − 8.2 % Budget allocated to RTOs and to Universities: 15%[97]	68(REC) out of 485 (all entity types) − 14 % 8 (HES) out of 485 (all entity types) − 1.7 % Budget allocated to RTOs and to Universities: 6.4 %[98]
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	Y	0 %	0 %

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[97] Cumulated amounts and percentages referring to beneficiaries and third party participants of the calls H2020-SESAR-2015-1, H2020-SESAR-2015-2, H2020-SESAR-2016-1, H2020-SESAR-2016-2

[98] Cumulated amounts and percentages referring to beneficiaries and third party participants of the call H2020-SESAR-2019-1 and to the project AUDIO (H2020-SESAR-2016-2)

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REF	Name of H2020 Key Performance Indicator	Definition	Data provided by SESAR JU[82]	Value in 2018	Value in 2019
		ethics clearance (target 45 days)			
38	Error rate (for H2020 grants)	% of representative error	Y	3.49 %	2.61 %
		% residual error		1.33 %	1.76 %
39	Implementation of ex-post audit results for H2020 projects	Number of cases implemented in total €million of cases implemented/total cases	Y	87 % (EUR 26 420 / EUR 30 366)[99]	68 % (EUR 166 767 / EUR 247 045) [100]

Table 14: Indicators for monitoring cross-cutting issues

8.1.2   Annex I.2: Scoreboard of KPIs specific to SESAR JU

The tables below provide an overview of KPIs specific to the SESAR JU:

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[99] Cumulative amount referring to 2017 and 2018
[100] Cumulative amount referring to 2017, 2018 & 2019

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REF	Name of H2020 Key Performance Indicator	Definition	Value in 2018	Value in 2019	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 (see Subsection 2.6.6 for explanations)	Forecasted leverage at the end of the programme: Method 1 (Interim Evaluation): 1,22 Method 2 (refined Interim Evaluation): 1,26 Method 3 (Horizon 2020): 2,26 Partnership leverage: 1,74	Forecasted leverage at the end of the programme: Method 1 (Interim Evaluation): 1,40 Method 2 (refined Interim Evaluation): 1,44 Method 3 (Horizon 2020): 2,44 Partnership leverage: 2,05	Programme target: Method 1 (Interim Evaluation): 1,40 Method 2 (Union Body leverage): 1,44 Method 3 (Horizon 2020): 2,44 Partnership leverage: 1,95
41	Completion of SESAR 2020 programme	Actual v Planned % complete per project as of the end of the reporting period	6 calls for proposals completed out of the 10 planned at the end of 2018 28 grants completed + 1 terminated 57 grants in execution	7calls for proposals completed + 1 ongoing out of the 10 planned at the end of 2019 62 grants completed + 1 terminated 37 grants in execution 31 grants in preparation	100 %

REF	Name of H2020 Key Performance Indicator	Definition	Value in 2018	Value in 2019	Target by 2024
42	Delivery of SESAR 2020 Solutions	Number of solutions ready for pre-industrialisation vs. plan	n/a (planned for Release 9)	n/a (planned for Release 9)	70%[101]

Table 15: KPIs specific to the SESAR JU – 2018 and 2019

Furthermore, the European ATM Master Plan defines the Performance Ambitions that the Single European Sky should achieve through the full implementation of its vision within the 2035 timeframe, provided that deployment would be achieved in an optimal and timely manner. The table below provides an overview of the SES Performance Scheme, composed of the list of key performance areas (KPAs), the related key performance indicators (KPIs) and the related Performance Ambitions:

REF	ATM Master Plan SES Performance Ambition KPA	KPI	ATM Master Plan overall SESAR 2020 Performance Ambition (vs. baseline 2012)
43	Cost efficiency	PA1	30-40% reduction in ANS costs per flight
44	Operational efficiency	PA2	3-6% reduction in flight time
		PA3	5-10% reduction in fuel burn
		PA4	Arrival predictability: 2 minute time window for 70% of flights actually arriving at gate
45	Capacity	PA5	10-30% reduction in departure delays
		PA6	5-10% additional flights at congested airports
		PA7	System able to handle 80-100% more traffic
46	Environment	PA8	5-10% reduction in CO2 emissions
47	Safety	PA9	Safety improvement by a factor 3-4
48	Security	PA10	No increase in ATM related security incidents resulting in traffic disruptions

Table 16: Single European Sky Performance Scheme as per the European ATM Master Plan

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[101] Approximate target. The estimated number of solutions will be refined in 2020 on the basis of the results of the call IR-VLD Wave 2.

The SESAR Programme is expected to achieve a significant portion of the SES Performance Scheme. That portion is defined in the SESAR Performance Framework, composed of key performance areas (SESAR KPAs and KPIs, linked with SES KPAs and KPIs) and the overall SESAR 2020 Ambition, which was updated in 2017 to recognise the achievements of the SESAR 1 Programme and to set the objectives for the SESAR 2020 programme.

In 2019, in continuation of the activities conducted in previous years, in collaboration with its Members with the support of project PJ.19, the SESAR JU assessed the performance benefits expected to result from the candidate solutions according to the KPAs. A consolidation exercise was conducted in 2019 which gave the following results (the achievements in the table below include those Solutions reaching the V3-TRL6 level of maturity only, not including performance results from candidate Solutions not yet in V3-TRL6 level of maturity):

KPA	Overall SESAR 2020 Ambition	Units	Cumulated SESAR 1 + SESAR 2020 V3 achievements
SAFETY	-51%	Reduction in accidents	-36.5%
Airport Capacity (CAP3)	10%	% increase peak hour throughput	18.5%
TMA Capacity (CAP1)	47%	% increase in peak hour throughput	27.7%
En-Route Capacity (CAP2)	49%	% increase in peak hour throughput	48.8%
Punctuality (PUN1)	7%	Increase in proportion of flights departing within +/- 3 minutes of SOBT	2.7%
Predictability (PRD1)	96%	Reduction in variance of block-to-block flight time	40.5%
Environment/Fuel Efficiency (FEFF1)	500	saving kg/flight	143,1
ATCO Productivity (CEF2)	97.7%	% increase in ATCO productivity	70.8%
Technology Cost (CEF3)	43.4%	% reduction in technology cost per flight	30.8%

Table 17: Performance ambitions, validation target starting point and SESAR 2020 Initial Performance assessment results (expectations)

8.1.3 Annex I.3: Procurement activity in 2019

In order to manage the timely implementation of its procurement activities supporting the implementation of the SESAR JU objectives for 2019, the SESAR JU used a contract action planning where all the procurement/contract activities are recorded over 2019. This file is updated on a weekly basis in concertation with OIAs and Corporate Management Team. This planning is a repository of all the procurement activities planned in the SPD as well as unforeseen activities at the time of the SPD adoption upon validation of the Corporate Management Team, and details the timeline for implementation of these activities on the basis of SESAR JU needs and applicable rules.

In particular, the SESAR JU launched and finalised the following procurement activities in 2019.

SAoO	Type of procedure	Description	Total budget (Est.)	Type of contract	Signed
5	EC Framework service Contract	Publication WAC	3.285 €	Purchase Order/ Order Form	06-02-2019
6	Call for Expression of interest	Audits and Controls	n.a.	EC Framework service Contract	13-02-2019
1	Framework service contract	3PRM - Professional Staff Organisations - Lot2 - IFATCA	79.700 €	Specific Contract	09-01-2019
1	Framework service contract	3PRM - Professional Staff Organisations - Lot4 - ECA	85.500 €	Specific Contract	08-01-2019
5	EC Framework service Contract	Communication support for graphical design	20.000 €	Specific Contract	
5	Framework service contract	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	74.641 €	Specific Contract	11-02-2019
6	Negotiated call for tender	ICT coordination	15.000 €	Service contract	04-03-2019
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material - LOT 2 Digital communication	34.880 €	Specific Contract	23-02-2019
1	Specific Contract	3PRM - Airspace Users - Lot 4	160.300 €	Amendment	08-03-2019
6	Joint Procurement	HR consultancy Services	n.a.	Framework service Contract	29-01-2019
6	Very Low Procurement	Extraordinary electric maintenance works	3.800 €	Purchase Order/ Order Form	18-03-2019

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SAoO	Type of procedure	Description	Total budget (Est.)	Type of contract	Signed
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	25.245 €	Specific Contract	19-03-2019
1	Specific Contract	3PRM - Airspace Users - Lot 3	167.400 €	Amendment	12-03-2019
1	Specific Contract	3PRM - Airspace Users - Lot 1	682.349 €	Amendment	14-03-2019
6	Open call for tender	ICT coordination	865.700 €	Framework service contract	29-03-2019
1	Framework service Contract	Airport Expertise (ACI) 2016-1019	250.000 €	Specific Contract	26-03-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 1	648.389 €	Specific Contract	09-04-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 3	348.350 €	Specific Contract	09-04-2019
5	Open call for tender	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	760.000 €	Framework service Contract	23-07-2019
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	166.948 €	Specific Contract	23-09-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 2	475.000 €	Specific Contract	01-07-2019
1	Framework service Contract	3PRM - Professional Staff Organisations - Lot2 - IFATCA	N/A	Amendment	22-08-2019
1	Framework service Contract	Airport Expertise (ACI) 2016-1019	250.000 €	Specific Contract	24-06-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 1	822.410 €	Specific Contract	24-05-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 1	648.389 €	Specific Contract	09-04-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 1	651.071 €	Specific Contract	19-06-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 2	269.645 €	Specific Contract	24-05-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 2	473.620 €	Specific Contract	10-04-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 3	348.350 €	Specific Contract	05-04-2019
1	Framework service Contract	3PRM - Airspace Users - Lot 4	162.300 €	Specific Contract	15-04-2019
1	Framework service Contract	3PRM - Professional Staff Organisations - Lot1 - ATCEUC	N/A	Amendment	03-06-2019

SAoO	Type of procedure	Description	Total budget (Est.)	Type of contract	Signed
1	Framework service Contract	3PRM - Professional Staff Organisations - Lot3 - ETF	N/A	Amendment	31/09/2019
1	Framework service Contract	3PRM - Professional Staff Organisations - Lot4 - ECA	N/A	Amendment	26-06-2019
1	Framework service Contract	3PRM - Professional Staff Organisations - Lot5 - IFATSEA	N/A	Amendment	22-05-2019
5	Open call for tender	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	760.000 €	Framework service Contract	23-09-2019
2	Call for Expression of interest	Scientific Committee	50.000 €	Expert Contract	n.a.
6	EC Framework service Contract	Order No 4 - DIGIT FWC 7470 with Comparex	15.160 €	Purchase Order/ Order Form	27-05-2019
6	Joint Procurement	Mission Coordination	100.000 €	EC Framework service Contract	20-12-2018
1	Call for Expression of interest	Call for Expression of Interest Ref. SJU/LC/136-CEI	N/A	Secondment agreement	n.a.
1	Call for Expression of interest	Call for Expression of Interest Ref. SJU/LC/128-CEI	N/A	Expert Contract	n.a.
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material	166.948 €	Specific Contract	23-07-2019
6	Negotiated call for tender	Data Protection	139,650 €	Service contract	09-08-2019
6	EC Framework service Contract	ICT Software	9.975 €	Specific Contract	30-10-2019
5	Open call for tender	Digital Communication, Event Support and other PR activities/ material - LOT 2 Digital communication	n.a.	Framework service Contract	07-11-2019
5	Open call for tender	Digital Communication, Event Support and other PR activities/ material - LOT 1 - Strategic communication	340.000 €	Framework service Contract	22-10-2019
6	Joint Procurement	Joint procurement procedure - Provision of assistance with staff selection procedure		Framework service Contract	18-10-2019
6	Joint Procurement	Joint procurement procedure - mise à disposition de travailleurs intérimaires		Framework service Contract	24-09-2019

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SAoO	Type of procedure	Description	Total budget (Est.)	Type of contract	Signed
6	EC Framework service Contract	ICT Software	15.160 €	Specific Contract	27-05-2019
5	Specific Contract	Digital Communication, Event Support and other PR activities/ material - LOT 3 Communication Events	-15.250 €	Amendment	02-12-2019
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material - LOT 2 Digital communication	84.642 €	Specific Contract	04-12-2019
6	Negotiated call for tender	Audit desk review	4.128 €	Service contract	22-11-2019
5	Framework service Contract	Digital Communication, Event Support and other PR activities/ material - LOT 1 - Strategic communication	67.541 €	Specific Contract	21-11-2019
2	Contest	Young Scientist Award	5.000 €	Prize	01-12-2019

Table 18: Main procurement activities launched and completed in 2019

8.2 Annex II. Statistics on financial management

Statistics on financial management are provided in part IIa, Section 3.3.

8.3   Annex III. Organisation chart

On 31 December 2019, the organisation chart was as follows:
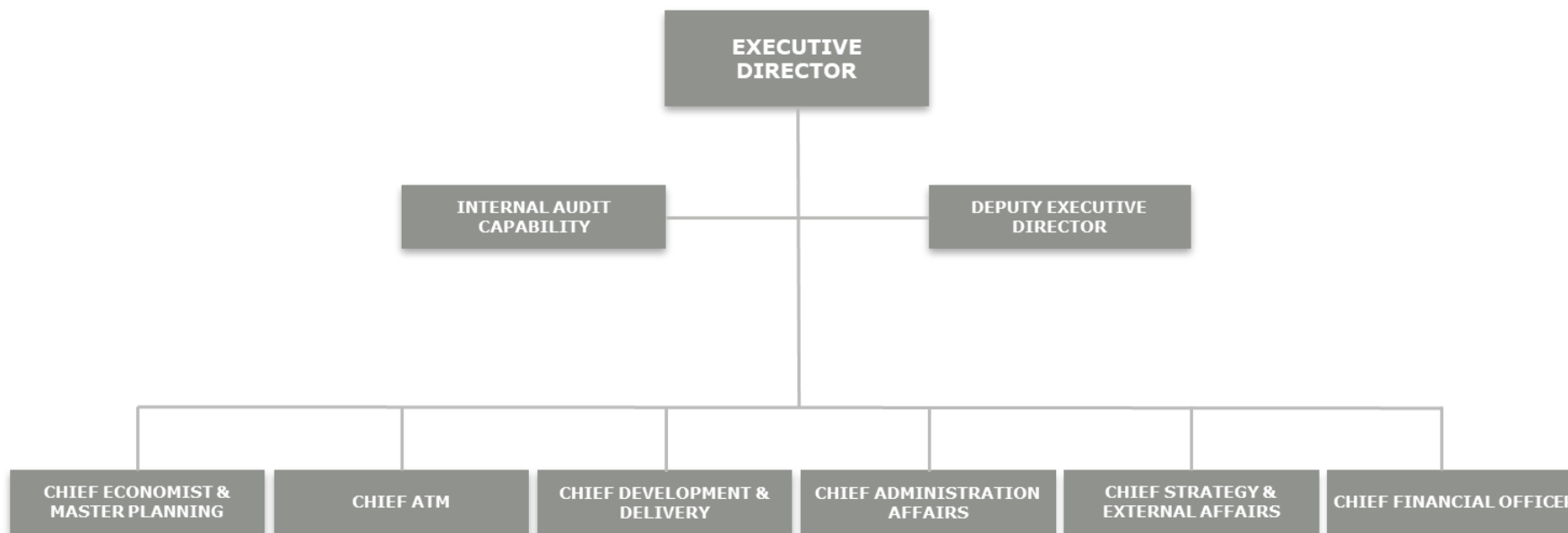
Figure 25: Organisation chart of the SESAR JU as at 31 December 2019

8.4 Annex IV. Establishment plan

Table of 39 positions per area and activity on 31 December 2019:

Key functions	Type of contract	Function group, grade of recruitment	Indication whether the function is dedicated to administrative support or operations
Executive Director	TA fixed term + renewable	AD 14 - external	operations
Chief Finance Officer (planned as of January 2020)	TA fixed term + renewable	AD 12 – external	administrative support
Internal Audit Capability	TA fixed term + renewable	AD 5 - external	50% administrative support 50% operations
Assistant to the Executive Director	TA indefinite (*)	AST 1 - external	administrative support
Deputy Executive Director Corporate Affairs[102]	TA indefinite (*)	AD 12 - external	50% administrative support 50% operations
Head of Corporate Support	TA indefinite (*)	AD 7 - external	administrative support
Administrative Assistant	TA indefinite (*)	AST 3 - external	administrative support
Administrative Assistant	TA fixed term + renewable	AST 3 - external	administrative support
Head of Corporate Quality, Planning & Reporting	TA fixed term + renewable	AD 8 - external	50% administrative support 50% operations
Programming & Planning Officer	TA fixed term + renewable	AST 4 - external	operations
Chief Strategy & External Affairs	TA indefinite (*)	AD 12 - external	operations
Head of International Affairs	TA fixed term + renewable	AD 10 - external	operations

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[102] The role of Deputy Executive Director is a functional role in the SESAR JU organisation responding to the need for the SESAR JU to ensure full continuity of its operations, and does not refer to provisions related to deputy heads of agencies in the Conditions of Employment of Other Servants

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Key functions	Type of contract	Function group, grade of recruitment	Indication whether the function is dedicated to administrative support or operations
Head of Stakeholders and Institutional Relations	TA fixed term + renewable	AD 10 - external	operations
Senior Communications & Media Relations Officer	TA fixed term + renewable	AD 5 - external	operations
Communications & Events Officer	TA fixed term + renewable	AD 5 - external	operations
Head of Release Management & Validation	TA fixed term + renewable	AD 7 - external	operations
Call Coordinator	TA fixed term + renewable	AD 9 - external	operations
Grant Manager	TA fixed term + renewable	AD 6 - external	operations
Grant Manager	TA fixed term + renewable	AD 6 - external	operations
Grant Manager	TA fixed term + renewable	AD 6 - external	operations
ATM Architecture Framework Expert	TA fixed term + renewable	AD 5 - external	operations
Chief ATM	TA fixed term + renewable	AD 10 - external	operations
ATM Expert – Architecture & Systems Engineering	TA fixed term + renewable	AD 8 - external	operations
ATM Expert - Airport & Airspace User Operations	TA fixed term + renewable	AD 6 - external	operations
ATM Expert - TMA, En-route & Network Operations	TA fixed term + renewable	AD 6 - external	operations
Chief Economist & Master Planning	TA indefinite (*)	AD 10 - external	operations
Manager Digital Transformation & Innovation	TA fixed term + renewable	AD 8 - external	operations
Chief Administration Affairs	TA fixed term + renewable	AD 12 - external	administrative
Project Auditor	TA fixed term + renewable	AD 5 - external	administrative

Key functions	Type of contract	Function group, grade of recruitment	Indication whether the function is dedicated to administrative support or operations
Head of Finance & Budget	TA fixed term + renewable	AD 8 - external	administrative support
Financial Officer	TA fixed term + renewable	AD 6 - external	administrative support
Financial Officer	TA fixed term + renewable	AD 5 - external	administrative support
Financial assistant	TA fixed term + renewable	AST 3 - external	administrative support
Head of Legal Affairs and Procurement	TA indefinite (*)	AD 8 - external	administrative support
Legal & Procurement Officer, Data Protection Officer	TA fixed term + renewable	AD 5 - external	administrative support
Legal & Procurement Officer	TA fixed term + renewable	AD 5 - external	administrative support
Legal & Procurement Officer	TA fixed term + renewable	AD 5 - external	administrative support
HR Legal Officer	TA fixed term + renewable (**)	AD 7 - external	administrative support
HR Officer	TA indefinite (*)	AST 7 - external	administrative support

Table 19: List of the 39 SESAR JU positions (31 December 2019)

(*) Staff member eligible to Transitional Provisions Article 2 of Council Regulation (EC) 1361/2008 (8 staff)

(**) Post currently covered by a CA with indefinite duration contract (position that is not additional to the 39 posts included in the Staff Establishment Plan approved by the Administrative Board of the SESAR Joint Undertaking, but they are contractual forms used by the SESAR JU to fill in specific posts taking into consideration the needs and expertise requested. The same is applicable for the staff seconded by the Members to the SESAR JU, in accordance with Article 8 of the SESAR JU Statutes.

8.5   Annex V. Human and financial resources by activity

Human and financial resources allocation by activity is provided in part IIa, Section 3.5.

8.6 Annex VI. Contribution, grant and service level agreements. Financial Framework Partnership Agreements

8.7   Annex VII. Specific annexes related to part II

Not applicable for 2019.

8.8   Annex VIII. Specific annexes related to part III

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
I. Control environment	1	Demonstrates commitment to integrity and ethical values	The Commission demonstrates a commitment to integrity and ethical values	Tone at the top. The Administrative Board and all management levels respect integrity and ethical values in their instructions, actions and behaviour.	3	3	
				Standards of conduct. The SESAR JU's expectations on integrity and ethical values are set out in standards of conduct and understood at all levels of the organisation, as well as by entrusted bodies, outsourced service providers and beneficiaries.	3		
				Alignment with standards. Processes are in place to assess whether individuals and departments are aligned with the SESAR JU's expected standards of conduct and to address deviations in a timely manner.	3		
	2	Exercises oversight responsibility	The College of Commissioners demonstrates independence from management and exercises oversight of the development and performance of internal control	The Administrative Board oversees the SESAR JU's governance, risk management and internal control practices and takes overall political responsibility for management carried out by the Executive Director. This happens through the use of appropriate working arrangements and communication channels between SESAR JU Areas.	3	3	
				Executive Director oversees the internal control systems within their Directorate-General. Executive Director oversees the development and performance of internal control. They are supported in this task by the Chief(s) in charge of risk management and internal control.	3		

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Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				In their capacity as Authorising Officer, Executive Director provides a Declaration of Assurance on the appropriate allocation of resources and their use for their intended purpose and in accordance with the principles of sound financial management, as well as on the adequacy of the control procedures in place (see Part V).	3		
				The Chief(s) in charge of risk management and internal control plays a key role by coordinating the preparation of the SESAR JU's Consolidated Annual Activity Report. In this context, they sign a declaration taking responsibility for the completeness and reliability of management reporting (see Section 5.4). This declaration covers both the state of internal control in the SESAR JU and the robustness of reporting on operational performance. However, responsibility for achieving operational objectives remains with the relevant directorate and unit.	3		
	3	Establishes structure, authority and responsibility	Management establishes, with political oversight, structures, reporting lines, and appropriate authorities and responsibilities in the pursuit of objectives	Management structures are comprehensive. The design and implementation of management and supervision structures cover all policies, programmes and activities. In particular for spending programmes, they cover all management modes, expenditure types, delivery mechanisms and entities in charge of budget implementation (i.e. both SESAR JU Areas and entrusted external entities) to support the achievement of policy, operational and control objectives	3	3	

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				Authorities and responsibilities. The SESAR JU and the Executive Director, as appropriate, delegate authority and use appropriate processes and technology to assign responsibility and segregate duties as necessary at the various levels of the SESAR JU.	3		
				Reporting lines. The Executive Director designs and evaluates reporting lines within departments and with entrusted entities to enable the execution of authority, fulfilment of responsibilities, and flow of information.	3		
	4	Demonstrates commitment to competence	The Commission demonstrates a commitment to attract, develop, and retain competent individuals in alignment with objectives	Competence framework. The Chiefs defines the competences necessary to support the achievement of objectives and regularly evaluate them across the SESAR JU, taking action to address shortcomings where necessary.	3		
				Professional development. SESAR JU Areas provide the training and coaching needed to attract, develop, and retain a sufficient number of competent staff.	3		
				Mobility. SESAR JU Areas promote and plan staff mobility so as to strike the right balance between continuity and renewal.	3	3	
				Succession planning and deputising arrangements for operational activities and financial transactions are in place to ensure continuity of operations.	3		

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Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
	5	Enforces accountability	The Commission holds individuals accountable for their internal control responsibilities in the pursuit of objectives	Enforcing accountability. The SESAR JU defines clear roles and responsibilities and holds individuals and entrusted entities accountable for the performance of internal control responsibilities across the organisation and for the implementation of corrective action as necessary.	3	3	
				Staff appraisal. Staff efficiency, abilities and conduct in the service are assessed annually against expected standards of conduct and set objectives. Cases of underperformance are appropriately addressed.	3		
				Staff promotion. Promotion is decided after consideration of the comparative merits of eligible staff taking into account, in particular, their appraisal reports.	3		
II. Risk assessment	6	Specifies suitable objectives	The Commission specifies objectives with sufficient clarity to enable the identification and assessment of risks relating to objectives	Mission. The SESAR JU Areas and Sections have up-to-date mission statements that are aligned across all hierarchical levels, down to the tasks and objectives assigned to individual staff members. Mission statements are aligned with the SESAR JU's responsibilities under the Treaties and the policy objectives set in the legal base.	3	3	
				Objectives are set at every level. The SESAR JU's objectives are clearly set and updated when necessary (e.g. significant changes in priorities, activities and/or the organigram). They are consistently filtered down from the SESAR JU level to the various levels of the organisation, and are communicated and understood by management and staff.	3		

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				Objectives are set for the most significant activities. Objectives and indicators cover the SESAR JU's most significant activities contributing to the delivery of SESAR JU priorities or other priorities relating to the core business, as well as operational management. Objectives must be SMART (specific, measurable, achievable, relevant and time-framed). Indicators must be RACER (relevant, accepted, credible, easy to monitor and robust).	3		
				Objectives form the basis for committing resources. Management uses the objectives set as a basis for allocating available resources as needed to achieve policy, operational and financial performance goals.	3		
				Financial reporting objectives. Financial reporting objectives are consistent with the accounting principles applicable in the SESAR JU.	3		
				Non-financial reporting objectives. Non-financial reporting provides management with accurate and complete information needed to manage the organisation at SESAR JU, SESAR JU Area and Sector level.	3		
				Risk tolerance and materiality. When setting objectives, management defines the acceptable levels of variation relative to their achievement (tolerance for risk) as well as the appropriate level of materiality for reporting purposes, taking into account cost-effectiveness.	3		

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				Monitoring. Setting objectives and performance indicators make it possible to monitor progress towards their achievement.	3		
	7	Identifies and analyses risk	The Commission identifies risks to the achievement of its objectives across the organisation and analyses risks as a basis for determining how the risks should be managed	Risk identification. The SESAR JU identifies and assesses risks at the various organisational levels (SESAR JU, SESAR JU Area, Section, cross-cutting across SESAR JU Areas) and those related to entrusted entities, analysing internal and external factors. Management and staff are involved in the process at the appropriate level.	3	3	
				Risk assessment. The SESAR JU estimates the significance of the risks identified and determines how to respond to significant risks considering how each one should be managed and whether to accept, avoid, reduce or share the risk. The intensity of mitigating controls is proportional to the significance of the risk.	3		
				Risk identification and risk assessment are integrated into the annual activity planning and are regularly monitored.	3		
	8	Assesses fraud risk	The Commission considers the potential for fraud in assessing risks to the achievement of objectives	Risk of fraud. The risk identification and assessment procedures (see principle 7) consider possible incentives, pressures, opportunities and attitudes which may lead to any type of fraud, notably fraudulent reporting, loss of assets, disclosure of sensitive information and corruption.	3	3	

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				Anti-fraud strategy. The SESAR JU sets up and implements measures to counter fraud and any illegal activities affecting the financial interests of the EU. They do this by putting in place a sound anti-fraud strategy to improve the prevention, detection and conditions for investigating fraud, and to set out reparation and deterrence measures, with proportionate and dissuasive sanctions.	3		
	9	Identifies and analyses significant change	The Commission identifies and assesses changes that could significantly impact the internal control system	Assess changes. The risk identification process considers changes in the internal and external environment, in policies and operational priorities, as well as in management's attitude towards the internal control system.	3	3	
III. Control activities	10	Selects and develops control activities	The Commission selects and develops control activities that contribute to the mitigation of risks to the achievement of objectives to acceptable levels	Control activities are performed to mitigate the identified risks and are cost-effective. They are tailored to the specific activities and risks of the SESAR JU and their intensity is proportional to the underlying risks.	3	2,75	The SESAR JU implements all control activities which are required from the key regulations and EC guidance (Financial Regulation and FFR, SESAR JU Regulation, Staff Regulation etc.)
				Control activities are integrated in a control strategy. The control strategy includes a variety of checks, including supervision arrangements, and where appropriate, should include a balance of approaches to mitigate risks, considering manual and automated controls, and preventive and detective controls.	2		Control activities must be defined in the context of the new Internal Control Framework

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				Segregation of duties. When putting in place control measures, management considers whether duties are correctly divided between staff members to reduce risks of error and inappropriate or fraudulent actions.	3		
				Business continuity plans based on a business impact analysis following corporate guidance are in place, up-to-date and used by trained staff to ensure that the Commission is able to continue working to the extent possible in case of a major disruption. Where necessary, business continuity plans must include coordinated and agreed disaster recovery plans for time-sensitive supporting infrastructure (e.g. IT systems).	3		
	11	Selects and develops general control over technology	The Commission selects and develops general control activities over technology to support the achievement of objectives	Control over technology. In order to ensure that technology used in business processes, including automated controls, is reliable, and taking into account the overall corporate processes, the SESAR JU selects and develops control activities over the acquisition, development and maintenance of technology and related infrastructure.	3	3	
				Security of IT systems. The SESAR JU applies appropriate controls to ensure the security of the IT systems of which they are the system owners. They do so in accordance with the IT security governance principles, in particular as regards data protection, professional secrecy, availability, confidentiality and integrity.	3		

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
	12	Deploys through policies and procedures	The Commission deploys control activities through corporate policies that establish what is expected and in procedures that put policies into action	Appropriate control procedures ensure that objectives are achieved. The control procedures assign responsibility for control activities to the department or individual responsible for the risk in question. The staff member(s) put in charge perform the control activities in a timely manner and with due diligence, taking corrective action where needed. Management periodically reassesses the control procedures to ensure that they remain relevant.	3	3	
				Exception reporting is one of the management tools used to draw conclusions about the effectiveness of internal control and/or the changes needed in the internal control system. A system is in place to ensure that all instances of overriding controls or deviations from established processes and procedures are documented in exception reports. All instances must be justified and approved before action is taken, and logged centrally.	3		
				The impact assessment and evaluation of expenditure programmes, legislation and other non-spending activities are performed in accordance with the guiding principles of the Commission's better regulation guidelines, to assess the performance of EU interventions and analyse options and related impacts on new initiatives.	3		

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Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
IV. Information and communication	13	Uses relevant information	The Commission obtains or generates and uses relevant quality information to support the functioning of internal control	Information and document management. SESAR JU identifies the information required to support the functioning of the internal control system and the achievement of its objectives. Information systems process relevant data, captured from both internal and external sources, to obtain the required and expected quality information, in compliance with applicable security, document management and data protection rules. This information is produced in a timely manner, and is reliable, current, accurate, complete, accessible, protected, verifiable, filed and preserved. It is shared within the organisation in line with prevailing guidelines.	3	3	
	14	Communicates internally	The Commission internally communicates information, including objectives and responsibilities for internal control, necessary to support the functioning of internal control	Internal communication. The SESAR JU communicates internally about their objectives, challenges, actions taken and results achieved, including but not limited to the objectives and responsibilities of internal control.	3	3	
				Separate communication lines, such as whistleblowing hotlines, are in place at the SESAR JU level to ensure information flow when normal channels are ineffective.	3		

Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
	15	Communicates externally	The Commission communicates with external parties about matters affecting the functioning of internal control	External communication. SESAR JU ensure that their external communication is consistent, relevant to the audience being targeted, and cost-effective. The SESAR JU establishes clear responsibilities to align its Areas communication activities with the SESAR JU's political priorities and narrative of the institution.	3	3	
				Communication on internal control. The SESAR JU communicates with external parties on the functioning of the components of internal control. Relevant and timely information is communicated externally, taking into account the timing, audience, and nature of the communication, as well as legal, regulatory, and fiduciary requirements.	3		
V. Monitoring activities	16	Conducts ongoing and/or separate assessments	The Commission selects, develops, and performs ongoing and/or separate assessments to ascertain whether the components of internal control are present and functioning	Continuous and specific assessments. The SESAR JU continuously monitors the performance of the internal control system with tools that make it possible to identify internal control deficiencies, register and assess the results of controls, and control deviations and exceptions. In addition, when necessary, the Directorate General carries out specific assessments, taking into account changes in the control environment. Ongoing assessments are built into business processes and adjusted to changing conditions. Both kinds of assessment must be based on the general principles set out in Appendix 1.	2	2,33	Control activities must be assessed in the context of the new Internal Control Framework
				Sufficient knowledge and information. Staff performing ongoing or separate assessments has sufficient knowledge and information to do this, specifically on the scope and	2		Control activities must be assessed in the context of the new Internal Control Framework

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Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
				completeness of the results of controls, control deviations and exceptions.			
				Risk-based and periodical assessments. The SESAR JU varies the scope and frequency of specific assessments depending on the identified risks. Specific assessments are performed periodically to provide objective feedback.	3		Control activities must be assessed in the context of the new Internal Control Framework

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Components	#	Principle	Description	Characteristics	Y - 1 SESAR JU's compliance	Principle avg	Comments / Actions plan
	17	Assesses and communicates deficiencies	The Commission assesses and communicates internal control deficiencies in a timely manner to those parties responsible for taking corrective action, including senior management and the College of Commissioners, as appropriate	Deficiencies. With the support of the Chief(s) in charge of risk management and internal control, the SESAR JU considers the results of the assessments of how the internal control system is functioning within the SESAR JU. Deficiencies are communicated to management and to the departments responsible for taking corrective action. They are reported in the Annual Activity Reports and to the responsible Administrative Board, as appropriate. The term 'internal control deficiency' means a shortcoming in a component or components and relevant principle(s) that reduces the likelihood of a SESAR JU achieving its objectives. There is a major deficiency in the internal control system if management determines that a component and one or more relevant principles are not present or functioning or that components are not working together. When a major deficiency exists, the SESAR JU cannot conclude that it has met the requirements of an effective system of internal control. To classify the severity of internal control deficiencies, management has to use judgment based on relevant criteria contained in regulations, rules or external standards.	3	3	
				Remedial action. Corrective action is taken in a timely manner by the staff member(s) in charge of the processes concerned, under the supervision of their management. With the support of the Chief(s) in charge of risk management and internal control, the Executive Director monitors and takes responsibility for the timely implementation of corrective action.	3		

Table 20: Assessment of the SESAR JU's Internal Control Framework at the end of 2019

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8.9   Annex IX. Provisional Annual Accounts

The Provisional Annual Accounts for 2019 are provided in a separate document which was officially handed over to the Budgetary Authorities, the European Court of Auditors (ECA) and the external auditors.

The main information in relation with the Provisional Annual Accounts for 2019 is the following:

Balance sheet:

	Note	31.12.2019	31.12.2018
NON-CURRENT ASSETS			
Intangible assets	*2.1*	*2*	*4*
Property, plant and equipment	*2.2*	*115*	*174*
Pre-financing	*2.3*	*48 456*	*10 928*
		48 573	**11 106**
CURRENT ASSETS			
Pre-financing	*2.3*	*7 267*	*60 902*
Exchange receivables and non-exchange recoverables	*2.4*	*45 800*	*77 852*
Cash and cash equivalents	*2.5*	*5*	*1*
		53 072	**138 755**
TOTAL ASSETS		**101 645**	**149 861**
CURRENT LIABILITIES			
Payables and other liabilities	*2.6*	*(186 743)*	*(123 368)*
Accrued charges and deferred income	*2.7*	*(30 235)*	*(93 990)*
		(216 978)	**(217 359)**
TOTAL LIABILITIES		**(216 978)**	**(217 359)**
NET ASSETS		**(115 333)**	**(67 498)**
Contribution from Members	*2.8*	*2 256 158*	*2 083 381*
Accumulated deficit		*(2 150 879)*	*(1 906 999)*
Economic result of the year		*(220 612)*	*(243 879)*
NET ASSETS		**(115 333)**	**(67 498)**

Statement of financial performance:

	Note	2019	2018
REVENUE			
Revenue from exchange transactions			
Financial revenue	*1*		–
		1	–
Total revenue		1	–
EXPENSES			
Operational costs	*3.1*	*(212 691)*	*(235 341)*
Staff costs	*3.2*	*(4 663)*	*(4 824)*
Finance costs		*(5)*	*(5)*
Other expenses	*3.3*	*(3 254)*	*(3 709)*
Total expenses		(220 614)	(243 879)
ECONOMIC RESULT OF THE YEAR		(220 612)	(243 879)

Cash flow statement[103]:

	2019	2018
Economic result of the year	*(220 612)*	*(243 879)*
Operating activities		
Depreciation and amortization	*76*	*71*
(Increase)/decrease in pre-financing	*16 106*	*10 438*
(Increase)/decrease in exchange receivables and non-exchange recoverables	*32 051*	*(16 515)*
Increase/(decrease) in payables	*63 375*	*21 910*
Increase/(decrease) in accrued charges & deferred income	*(63 755)*	*18 044*
Increase/(decrease) in cash contributions	*118 714*	*95 920*
Increase/(decrease) in in-kind contributions	*54 063*	*114 064*
Investing activities		
(Increase)/decrease in intangible assets and property, plant and equipment	*(14)*	*(57)*
NET CASHFLOW	4	(5)
Net increase/(decrease) in cash and cash equivalents	*4*	*(5)*
Cash and cash equivalents at the beginning of the year	*1*	*7*
Cash and cash equivalents at year-end	*5*	*1*

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[103] Following the appointment of the Accounting Officer of the Commission as the Accounting Officer of SESAR JU, the treasury of SESAR JU was integrated into the Commission's treasury system. Because of this, SESAR JU has only one bank account of its own covering the bank guarantee issued for the rental of the SESAR JU premises. All payments and receipts are processed via the Commission's treasury system and registered on intercompany accounts, which are presented under the heading exchange receivables.

Founding Members

Result of the implementation of the budget:

	Title	2019	2018
Revenue		124 778	97 887
of which:			
Contribution from the European Union	1	114 136	88 185
Contribution from Eurocontrol	2	1 848	5 189
Contribution from other members	3	2 730	2 546
Other revenue	4	6 064	1 967
Expenditure		(151 505)	(78 626)
of which:			
Staff expenditure	1	(5 325)	(5 220)
Administrative expenditure	2	(2 449)	(4 220)
Operational expenditure	3	(143 731)	(69 186)
Exchange rate differences		0	0
Budget result		(26 727)	19 262

8.10 Annex X. Other annexes

8.10.1 X.1 List of acronyms and definitions

Acronym	Long Name / Definition
AAS	Airspace Architecture Study
ABAS	Aircraft-Based Augmentation System
ABMS	Agent-Based Modelling & Simulation
ACC	Area Control Centres
A-CDM	Airport Collaborative Decision Making
ACI	Airports Council International
AD	Administrator grade
ADS-B	Automatic Dependence Surveillance-Broadcast
ADS-C	Automatic Dependence Surveillance-Contract
AI	Artificial Intelligence
AIM	Aeronautical Information Management
AIXM	Aeronautical Information Exchange Model
AMAN/DMAN	Arrival Manager/Departure Manager
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOP	Airport Operation Plan
ASAS	Airborne Separation Assurance System
ASBUs	Aviation System Block Upgrades
ASM	AirSpace Management
AST	Assistant grade
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATCO	Air Traffic Control Officer
ATN	Aeronautical Telecommunication Network

Acronym	Long Name / Definition
ATSU	Air Traffic Services Unit
AU	Airspace Users (Civil)
BVLOS/VLOS	Beyond Visual Line Of Sight/Visual Line Of Sight
CA	Contract Agent
CAP	Collaborative Advanced Planning
CDM	Collaborative Decision Making
CEF	The Connecting Europe Facility Programme
CNS	Communication, Navigation, Surveillance
CONOPS	Concept of Operations
CRS	Common Representative Sample
CTA	Controlled Time of Arrival
CWP/CWPV	Controller Working Position/Controller Working Position Virtualisation
DAC	Dynamic Airspace Configurations
DAPs	Downloaded Aircraft Parameters
DCB	Demand and Capacity Balancing
DFS	Deutsche Flugsicherung
DG	Directorate-General of the European Commission
DME	Distance Measuring Equipment
DMSC	Delivery Management Sub-Committees
DPO	Data Protection Officer
DSNA	Direction des services de la Navigation aérienne
EASA	The European Aviation Safety Agency
EASCG	The European Air Traffic Management Standards Coordination Group
EC	The European Commission
ECTRL	Eurocontrol
EDA	The European Defence Agency
EEC	Eurocontrol Experimental Centre
EFB	Electronic Flight Bag

Acronym	Long Name / Definition
EFVS	Enhanced Flight Vision Systems
EGNOS	European Geostationary Navigation Overlay Service
EPP	Extended Projected Profile
ER	exploratory research
EUROCAE	European Organisation for Civil Aviation Equipment
EUSCG	The European UAS Standards Coordination Group
EU	European Union
FAA	Federal Aviation Administration
FCI	Future Communication Infrastructure
FFR	Framework Financial Regulation
FIS-B	Flight Information System-Broadcast
FMP	Flow Management Positions
FMS	Flight Management System
FOC	Full Operational Capability
FP7	7th Framework Programme of the European Union
FPL	Flight Plan
FRA	Free Route Airspace
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
GPS	The Global Positioning System
H2020	Horizon 2020, the Framework Programme for research and Innovation (2014-2020)
HES	Higher or Secondary Education Organisation
HMI	Human Machine Interface
IA	Innovation Action
IAC	Internal Audit Capability

Acronym	Long Name / Definition
IAS	Internal Audit Service
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
INAP	Integrated Network ATM Planning
INCS	Independent Non-Cooperative Surveillance (sensors)
IOP	Inter-operability
IPS	Internet Protocol Suite
IR	industrial research & validation
JTI	Joint Technology Initiative
KPAs/KPIs	Key Performance Areas/Key Performance Indicators
KTN	Knowledge Transfer Network
LDACS	L-band Digital Aeronautical Communication System
LPV	Localizer Performance with Vertical Guidance
MAWP	SESAR 2020 Multi-Annual Work Programme
MET	Meteorological
MLAT	Multilateration
MoC	Memorandum of Cooperation
MoU	Memorandum of Understanding
MPC	The Master Planning Committee
MSPSR	Multi-Static Primary Surveillance Radar
MUAC	Maastricht Upper Area Control
NM	Network Manager
NMF	Network Management Function
NOP	Network Operation Plan
OAT	Operational Air Traffic
OBPMA	On-Board Performance Monitoring Alerts
OI	Operational Improvement
PBN	Performance-Based Navigation

Acronym	Long Name / Definition
PC	Programme Committee
PCP	Pilot Common Project
PPP	Public Private Partnership
PRC	Private for Profit Organisation
R&D	research and Development
REC	research Organisation
RF	Retrofit
R&I	research & Innovation
RNP	Required Navigation Performance
RPAS	Remotely Piloted Aircraft System
RSP	Required Surveillance Performance
RTCA	Radio Technical Commission for Aeronautics
RTOs	research and Technology Organisations
RTS	Real Time Simulation
RVR	Runway Visual Range
SAoO	SESAR JU Strategic Area of Operation
SATCOM	Satellite Communications
SBT/RBT	Shared Business Trajectory/Reference Business Trajectory
SDM	SESAR Deployment Manager
SEAC 2020	SESAR European Airports Consortium
SES	Single European Sky
SESAR	Single European Sky ATM research is the SESAR research and innovation programme (called SESAR 1 for the period covering 2008 to 2016, and SESAR 2020 starting in 2015 with a maximum period for award of grants ending in December 2020)
SESAR 1	The SESAR 1 research and innovation programme, also referred to as the SESAR 1 Programme or SESAR 1 R&I Programme, is the coordinated set of activities undertaken by the Members other than the Union and managed by the SESAR JU over the period from 2008 through to 2016
SESAR 2020	The SESAR 2020 research and innovation programme, also referred to as the SESAR 2020 programme or SESAR 2020 R&I Programme, is the coordinated set of activities described in this document and being undertaken by the Members other than the Union and managed by the SESAR JU, starting in 2015 with a maximum period for award of grants ending in December 2020

Acronym	Long Name / Definition
SESAR JU	SESAR Joint Undertaking
SIDs	SESAR Innovation Days
SMEs	Micro, small and medium-sized enterprises
SNE	Seconded National Expert
STAM	Short Term ATFCM Measures
SWIM	System Wide Information Management
SWIM-TI	System Wide Information Management Technical Infrastructure
TA	Temporary Agent
TMA	Terminal Control Area
TRA	The EU Transport research Arena
TRL	Technology Readiness Level
TTA	Target Time Arrival
TTG	Time to Grant (H2020 Grant Lifecycle)
TTI	Time to Inform (H2020 Grant Lifecycle)
TTS	Time to Sign (H2020 Grant Lifecycle)
UAS	Unmanned Aerial System
UDPP	User Driven Prioritisation Process
UTM	UAS Traffic Management
VFR	Visual Flight Rules
VLD	very large-scale demonstration
VLL	Very Low-Level
WAM	Wide Area Multilateration
WOC	Wing Operations Centre
WP	Work Programme
YSA	SESAR Young Scientist Award

Table 21: List of acronyms and definitions

8.10.2 X.2   Composition of the Administrative Board as at 31 December 2019

SESAR JU Founding Members	Member	Alternate
European Union	Mr Henrik Hololei (Chair), European Commission	Mr Filip Cornelis
Eurocontrol	Mr Eamonn Brennan (Deputy Chair), Eurocontrol Agency	Mr Philippe Merlo
SESAR JU Members	**Member**	**Alternate**
Airbus	Mr Bruno Darboux	Mr Hugues de Beco
AT-One consortium	Prof. Dr.-Ing. Dirk Kügler	Dr Helmut Többen
B4-consortium	Mr Maciej Rodak	Mr Lubos Hlinovsky
COOPANS	Mr Mikael Ericsson	Ms Miriam le Fevre
Dassault Aviation	Mr Alain Boucher	Ms Catherine Champagne
DFS	Mr Robert Schickling	Mr Gerard Tauss
DSNA	Mr Maurice Georges	Mr Philippe Barnola
ENAIRE	Mr Angel Luis Arias	Ms Mariluz de Mateo
ENAV		Mr Cristiano Cantoni
Leonardo	Mr Luigi Iacometta	Mr Fabio Ruta
Frequentis	Mr Hermann Mattanovich	Mr Michael Holzbauer
Honeywell	Mr George Papageorgiou	Mr Sander Roosendaal
INDRA	Mr Rafael Gallego Carbonell	Mr Ramon Tarrech
NATMIG	Mr Trond Runar Hagen	Mr Trond Bakken
NATS	Mr Dave Curtis	
SEAC	Mr Gérard Poetsch	Mr Fredrik Nygaard
Skyguide	Mr Thomas Buchanan	Mr Pascal Latron
Thales LAS France SAS	Mr Luc Lallouette	Mr Todd Donovan
Thales AVS France SAS	Mr Philippe Benquet	Mr Pascal Combe
Stakeholder Representatives	**Member**	**Alternate**
Military	MG (ret.) Eric Labourdette Mr Jorge Domecq	Mr Per Coulet Mr Emilio Fajardo
Civil users of airspace	Mr Giancarlo Buono	Mr Robert Baltus
	Ms Sylviane Lust (permanent observer)	

Air Navigation Service Providers	Ms Tanja Grobotek	Mr Edouardo Garcia Gonzalez
Equipment manufacturers	Mr Vincent de Vroey	Mr Benjamyn Scott
Airports	Mr Olivier Jankovec	Mr Aidan Flanagan
Staff in the ATM sector	Mr Michele Altieri	Mr Theodore Kyritsis
Scientific community	Prof. Peter Hecker	Prof. Jacco Hoekstra
Permanent Observers	**Member**	**Alternate**
European Commission – Directorate General for research and Innovation	Mr Sebastiano Fumero	n/a
Permanent Representatives	**Member**	**Alternate**
SESAR JU Executive Director	Mr Florian Guillermet	n/a
SESAR JU Deputy Executive Director	Mr Peter Hotham	n/a
SESAR JU Chief Administration Affairs	Mr José Calvo Fresno	n/a
SESAR JU Internal Audit	Ms Véronique Haarsma	n/a
Secretary of the Board	Ms Ilaria Vazzoler	n/a

Table 22: Composition of the SESAR JU Administrative Board as at 31 December 2019

SESAR
JOINT UNDERTAKING

founding members

EUROPEAN UNION   EUROCONTROL

Members

AIRBUS

AT-One

B4 CONSORTIUM

COOPANS
REAL COOPERATION, REAL RESULTS

DASSAULT AVIATION

DFS Deutsche Flugsicherung

dgac
DSNA

ENAIRE

enav

FREQUENTIS
SESAR
PARTNERS
Frequentis • Atos • HungaroControl

Honeywell

indra

LEONARDO

NATMIG

NATS

SEAC

skyguide

THALES

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