SESAR 3 Joint Undertaking

BIANNUAL WORK PROGRAMME

2022-2023

Fifth amended version

EUROPEAN PARTNERSHIP

Co-funded by the European Union

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Bi-Annual Work Programme for years 2022-2023 - Fifth amended version

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This document is the **fifth amended version** of the Bi-Annual Work Programme of the SESAR 3 Joint Undertaking (SESAR 3 JU) for the 2022-2023 period.

This work programme covers 2022 and 2023. It is therefore referred to interchangeably as the 'annual work programme' and the 'biannual work programme'.

The information contained in this work programme (including the list of topics, budget and planning of calls) may be subject to updates. Any further amendments to the work programme will also be made publicly available after its adoption by the Governing Board.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

The Single European Sky ATM Research 3 Joint Undertaking is funded by the European Union, the European Organisation for the Safety of Air Navigation (EUROCONTROL) and members other than the Union as listed in Annex III of Council Regulation (EU) 2021/2085.

In accordance with Council Regulation (EU) 2021/2085 and with Article 33 of the financial rules of the SESAR 3 Joint Undertaking, the work programme will be made publicly available after its adoption by the Governing Board.

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List of abbreviations

Abbreviation	Definition
4D	four-dimensional
ABAC	attribute-based access control
ABAS	aircraft-based augmentation system
A-CDM	airport collaborative decision-making
ACI	Airports Council International
ADS-B	automatic dependent surveillance broadcast
ADS-C	automatic dependent surveillance contract
ADSP	ATM data service provider
AI	artificial intelligence
AMAN	arrival management
ANS	air navigation service
ANSP	air navigation service provider
AOP	airport operational planning
A-PNT	alternative position, navigation and timing
ARES	European Commission’s advanced records system
ATC	air traffic control
ATCO	air traffic controller
ATFCM	air traffic flow and capacity management
ATFM	air traffic flow management
ATM	air traffic management
ATN	Aeronautical Telecommunications Network
ATS	air traffic service
ATSEP	air traffic safety electronics personnel
ATSU	air traffic service unit
AU	airspace user
BAWP	biannual work programme

CA	contract agent
CANSO	Civil Air Navigation Services Organisation
CAS	Common Audit Service of the Directorate-General for Research and Innovation
CBA	cost–benefit analysis
CDM	collaborative decision-making
CEF	Connecting Europe Facility
CINEA	European Climate, Infrastructure and Environment Executive Agency
CNS	communications, navigation and surveillance
CO_2	carbon dioxide
CPDLC	controller–pilot datalink communications
CTA	controlled time of arrival
CTOT	calculated take-off time
D&E	dissemination and exploitation
DAA	detect and avoid
DCB	demand–capacity balancing
DCDP	direct controller–pilot communication
DES	Digital European Sky programme
DFMC	dual-frequency multi-constellation
DMA	dynamic mobile area
DMAN	departure management
DME	distance-measuring equipment
DMP	data management plan
DMSC	Delivery Management Subcommittee
DSD	Digital Sky Demonstrator
EASA	European Union Aviation Safety Agency
ECAC	European Civil Aviation Conference
ECHO	European concept of operations for higher airspace operations
EDA	European Defence Agency
EDPS	European Data Protection Supervisor

EFB	electronic flight bag
EFTA	European Free Trade Association
EPP	extended projected profile
ER	exploratory research
ESA	European Space Agency
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	US Federal Aviation Administration
FF-ICE	flight and flow information for a collaborative environment
FMP	flow management position
FMS	flight mangement system
FOC	flight operations centre
FTE	full-time equivalent (staff)
GANP	global air navigation plan (from the International Civil Aviation Organization)
GAST-D	GBAS approach service type D
GAST-F	GBAS approach service type F
GBAS	ground-based augmentation system
GNSS	global navigation satellite system
GPS	Global Positioning System
HAO	high-altitude operation
HMI	human–machine interface
IAS	Internal Audit Service
ICAO	International Civil Aviation Organization
ICT	information and communications technology
IDMS	information and document management system
IFR	instrument flight rules
IKOP	in-kind contributions to operational activities
INAP	integrated network management and ATC planning
IoT	internet of things

IP	Internet Protocol
IPS	Internet Protocol suite
IR	industrial research and validation
IT	information technology
KPA	key performance area
KPI	key performance indicator
LDACS	L-band Digital Aeronautical Communications System
LDACS-NAV	LDACS Navigation
MAWP	multiannual work programme
ML	machine learning
MRS	minimum radar separation
MWS	minimum wake separation
NADP	noise abatement departure procedure
NextGen	next generation air transportation system
NM	Network Manager
NOP	network operations portal
OSED	operational services and environment description
PBN	performance-based navigation
PDCA	plan, do, check and act or improve
PR	public relations
QICT	Quality and Information and Communications Technology
QMS	quality management system
R&D	research and development
R&I	research and innovation
RIA	research and innovation action
RNP	required navigation performance
RPAS	remotely piloted aircraft system
SatCom	satellite communications
SBAS	satellite-based augmentation system

SC	Scientific Committee, established in accordance with Council Regulation (EU) 2021/2085 Article 154
SES	Single European Sky
SESAR	Single European Sky ATM Research
SESAR 2020	SESAR 2020 innovation R & I programme, also referred to as the 'SESAR 2020 Programme' or 'SESAR 2020 R & I Programme'. It is the coordinated set of activities described in this document, being undertaken by the SESAR JU Members and managed by the SESAR JU
SESAR JU	Single European Sky ATM Research Joint Undertaking, established as a joint undertaking within the meaning of Article 187 of the Treaty on the Functioning of the European Union, established under the SESAR JU basic act
SESAR JU basic act	Council Regulation (EC) No 219/2007 of 27 February 2007 (OJ L 64, 2.3.2007, p. 1) on the establishment of a joint undertaking to develop the new generation European air traffic management system (SESAR), as amended by Council Regulation (EC) No 1361/2008 of 16 December 2008 (OJ L 352, 31.12.2008, p. 12) and by Council Regulation (EU) No 721/2014 of 16 June 2014 (OJ L 192, 1.7.2014, p. 1)
SESAR 3 JU	Single European Sky ATM Research 3 Joint Undertaking
SID	standard instrument departure
Single Basic Act	Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014
SLA	service-level agreement
SMEs	small and medium-sized enterprises
SRIA	strategic research and innovation agenda
STAM	short-term ATFCM measures
STAR	standard arrival route
SWIM	system-wide information management
TA	temporary agent
TBO	trajectory-based operation
TBS	time-based separation
TOD	top of descent
TLS	target level of safety
TMA	terminal manoeuvring area
TRL	technology readiness level

UAM	urban air mobility
UAS	unmanned aerial system
UAV	unmanned aerial vehicle
UDPP	user-driven prioritisation process
U-space	A set of new services relying on a high level of digitalisation and automation of functions, and specific procedures designed to support safe, efficient and secure access to airspace for a large numbers of drones, with an initial look at very low-level operations
VFR	visual flight rules
VHF	very high frequency
VLD	very-large-scale demonstration
vSTAM	very Short term ATFCM measure
VTOL	vertical take-off and landing
WA	work area
WER	wake energy retrieval
WOC	wing operations centre

Table 1: List of acronyms and definitions

Message from the Executive Director

Change is literally in the air. The combination of the climate and COVID-19 crises has accelerated a societal shift towards more sustainable air transport. Our industry is responding by stepping up efforts to make flying smarter and more sustainable.

While an energy transition is the only way to ensure carbon-neutral air transport in the long term, we are showing that aviation infrastructure (air traffic management (ATM)) can be modernised at a more rapid pace, bringing environmental benefits in the shorter term.

However, transforming the infrastructure that supports European aviation requires close collaboration between all the stakeholders that contribute to it. A public–private partnership that is strongly linked to policy and regulation through an institutional partnership offers the best means to coordinate all stakeholders, pooling the critical mass of resources and expertise needed to bring about this transformation, to deliver the Digital European Sky.

Launched in December 2021, the Single European Sky ATM Research 3 Joint Undertaking (SESAR 3 JU) and its Digital European Sky programme builds on the work and achievements of earlier SESAR research and innovation programmes (SESAR 1 and SESAR 2020), but seeks to accelerate the market uptake of innovative solutions through a portfolio of demonstrators and a fast-track mechanism. The partnership will provide a catalyst for speeding up the transition towards a green, climate-neutral and digital Europe, and for making European industry more resilient and competitive.

These strategic objectives must now be translated into a detailed plan of short-term work. This is the role of this work programme for 2022–2023. This work programme sets out the operational and support activities, as established within the context of SESAR 2020, that remain to be completed, while also detailing the priorities and plans for the SESAR 3 JU's new Digital European Sky programme of research and innovation.

Key to the success of our work will be having the right support, governance and human resources in place at the right time. In addition, the SESAR 3 JU will seek to continually improve the quality, performance, internal control and information and communications technologies infrastructure delivered, as well as to invest in its talented people.

Richard Frizon

Executive Director *ad interim* of the SESAR 3 JU

Chapter I – Introduction

The biannual work programme (BAWP) for 2022 and 2023 of the Single European Sky ATM Research 3 Joint Undertaking (SESAR 3 JU ([1])) outlines the scope of the research and innovation (R&I) activities that will be performed in 2022 and 2023, implemented through open call(s) for proposals and call(s) for tenders. It also details the resources of the SESAR 3 JU for this period in the staff establishment plan and in the budget.

The 2022–2023 BAWP should be read in conjunction with the SESAR 3 JU multiannual work programme (MAWP), which establishes the overall principles and framework under which the operations of the SESAR 3 JU will be defined, planned and executed from 2021 to 2031. In particular, the MAWP introduces the following elements.

- The policy context of the SESAR 3 JU (set out in Section 1.2 of the MAWP) defines the relationship between the SESAR 3 JU and the main policy initiatives of the EU, namely the single European sky policy framework and the European Commission's sustainable and smart mobility strategy (including the drone strategy 2.0), European Green Deal and 'Europe fit for the digital age' priorities.
- Its strategic objectives focus on building a Digital European Sky, as defined in the European ATM Master Plan (2020 edition), the main planning tool for air traffic management (ATM) modernisation across Europe (set out in Section 1.4 of the MAWP). The Master Plan connects ATM R&I activities with deployment activities and scenarios, with the aim of achieving the performance objectives of the single European sky programme and the policy objectives of the EU; the objectives of the SESAR 3 JU are set out in the Single Basic Act ([2]) and introduced in Section 1.3 of the MAWP.
- The overall R&I activities carried out from 2021 to 2031 are referred to as the 'Digital European Sky' programme. They are organised in the SESAR innovation pipeline described in Sections 2.2.1 and 2.2.3 of the MAWP.
- Other activities necessary to achieve the strategic objectives (set out in Section 2.3) aim to:
  - leverage synergies with other European partnerships and with national or regional ATM modernisation programmes;
  - ensure engagement among institutional and industry stakeholders;
  - secure cooperation with non-EU countries and international organisations;
  - promote the SESAR 3 JU activities and results through communication initiatives.
- The final element is its governance (in Section 3 of the MAWP).

According to Article 174 of the Single Basic Act, the SESAR 3 JU 'is the legal and universal successor in respect of all contracts, including employment contracts and grant agreements, liabilities and acquired property of the SESAR Joint Undertaking …, which it shall replace and succeed'. The SESAR 3 JU is also responsible for the closure of the SESAR 2020 programme (an R&I programme made up of

(1) The SESAR 3 JU was established as a joint undertaking within the meaning of Article 187 of the Treaty on the Functioning of the European Union, established under the Single Basic Act.

(2) Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014, OJ L 427, 30.11.2021, p. 17.

a coordinated set of activities undertaken by the SESAR JU members, managed by the SESAR JU and financed under the multiannual financial framework for 2014–2020) and the finalisation of the delivery of SESAR solutions.

Therefore, the 2022–2023 BAWP also provides information on the supervision and closure of the SESAR 2020 programme, and its structure clearly distinguishes between the two programmes managed by the SESAR 3 JU (i.e. the SESAR 2020 programme and the Digital European Sky programme) every time it is possible to do so.

Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, there is currently no appropriate context allowing the implementation of the actions foreseen in this programme with legal entities established in Russia, Belarus, or in non-government controlled territories of Ukraine. Therefore, such legal entities are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons. This criterion also applies in cases where the action involves financial support given by grant beneficiaries to third parties established in Russia, Belarus or in non-government controlled territories of Ukraine (in accordance with Article 204 of the Financial Regulation No 2018/1046).

1 Mission statement

The SESAR 3 JU supports several important policy initiatives of the EU.

First among them is the **Single European Sky policy**, which, through its regulatory and economic components (SES2+, performance and charging schemes) seeks to reform the European ATM system with the aim of improving its performance in terms of capacity, safety, efficiency and environmental impact. As its technological pillar, the SESAR project comprises three interrelated, continuous and evolving collaborative processes ('SESAR life cycle') that define, develop and deploy technological systems and operational procedures in line with the 2020 edition of the European ATM Master Plan, Europe's roadmap for ATM modernisation. Within this project framework, the SESAR 3 JU is responsible for the definition and development processes of the SESAR life cycle, establishing, through its work programme, an innovation pipeline through which concepts are transformed into tangible solutions for market uptake.

The establishment of the SESAR 3 JU within the framework of the Horizon Europe programme under the cluster on climate, energy and mobility recognises the contribution of ATM to making aviation more climate- and environment-friendly, more efficient and competitive, smarter, safer and more resilient and the need to address the research to demonstration challenges facing ATM in a partnership with all stakeholders, thus helping bridge the transition towards deployment while engaging ATM stakeholders in these steps.

The ambition of building a Digital European Sky, as defined in the European ATM Master Plan, matches the ambitions of the European Commission's **Sustainable and Smart Mobility Strategy**, and its **European Green Deal** and **Europe fit for the digital age** priorities. All three initiatives have given fresh momentum to the modernisation of aviation in order to achieve the ambitious goal of climate neutrality by 2050. They also make a clear link between digitalisation and the positive role it can play in sustainability and serving people and adding value to their lives.

The MAWP (in Section 1.6) provides the following mission statement for the SESAR 3 JU: **to accelerate through research and innovation the delivery of an inclusive, resilient and sustainable digital European sky:**

- accelerate – reducing the time to market through focused and agile R&I, supporting faster transition to deployment through an extended innovation life cycle;
- inclusive – integrating and connecting all types of air vehicles and users, including civil and military, manned and unmanned;
- resilient – enabling flexible, scalable, safe and secure ATM that can withstand disruptions in the aviation system;
- sustainable – establishing Europe as the most efficient and environmentally friendly sky to fly in the world.

2 Link with the strategic research and innovation agenda

2.1 Nine flagships of the strategic research and innovation agenda

The strategic research and innovation agenda (SRIA)([3]) presents the strategic R&I roadmaps for 2021–2027 for delivering on the implementation of the Digital European Sky programme (i.e. fully scalable services supported by a digital ecosystem, minimising the environmental footprint of aviation), including the integration of drones, while matching the ambitions of the European Green Deal and the 'Europe fit for the digital age' initiative.

The activities outlined in the SRIA to build a digitalised infrastructure are also critical for the post-COVID-19 recovery, enabling aviation to become more scalable, economically sustainable, environmentally efficient and predictable.

To achieve the Digital European Sky (phase D of the European ATM Master Plan), nine R&I flagships (referred to as 'destinations' in Horizon Europe) have been identified in the SRIA, along with their underlying R&I needs/challenges ([4]). These will be the basis for identifying future solutions that address phase D of the upgrade of the European ATM system (see Section 1.5 of the MAWP), as targeted by the Digital European Sky programme. The nine flagships are listed below, while the 59 related R&I needs are described in more detail in Appendix B of the MAWP, 'SRIA flagships and their R&I needs'.

1. **Connected and automated air traffic management**

The vision of the Digital European Sky recognises that the future ATM environment will be increasingly complex, with new airspace vehicles flying at different speeds and altitudes from conventional aircraft. Moreover, there will be increasing pressure to reduce the costs of the ATM infrastructure while improving performance. Secure data-sharing between all components of the ATM infrastructure and the relevant stakeholders is a key part of the Digital European Sky, as is automation using the shared data to improve ATM performance. This flagship identifies the specific research needed to realise the automation and connectivity vision of the European ATM Master Plan for the future ATM ground system.

Expected impact. These activities will boost the level of automation that can be achieved in the relevant areas. This will contribute to achieving the European ATM Master Plan vision to reach at least level 2 (task execution support) for all air traffic control (ATC) tasks and up to level 4 (high automation) for certain tasks. The impact on U-space ([5]) services will be even greater, where the goal is between level 4 and level 5 (full automation) for all relevant tasks. Higher levels of automation are considered an essential enabler for increasing the performance of the socio-technical ATM system.

An affordable and service-oriented way of sharing trajectories across ATM actors will be available, enabling the capacity, cost-efficiency, operational efficiency and environmental performance

([3]) The document is available on the SESAR 3 JU website.

([4]) The Master Plan explicitly states that essential operational changes are defined only for elements that are 'in the pipeline towards deployment' (phases A–C) and therefore these are not defined for phase D, which is the central focus of SESAR 3. The nine flagships identified in the SRIA (which focuses on the how) were derived from the phase D vision defined in the Master Plan (which focuses on the why, what and when).

([5]) U-space encompasses a set of new services relying on a high level of digitalisation and automation of functions, and specific procedures designed to support safe, efficient and secure access to airspace for a large numbers of drones, with an initial look at very low-level operations.

ambitions of the European ATM Master Plan to be achieved for controlled airspace and airports. Unmanned traffic will have been integrated with manned traffic where required and will utilise additional airspace resources where available in an efficient and safe manner.

The future ATM system will deliver hyperconnectivity between all stakeholders (vehicle-to-vehicle and vehicle-to-infrastructure) via high-bandwidth, low-latency ground-based and satellite networks. Highly automated systems with numerous actors will interact with each other seamlessly with fewer errors, making the system scalable and even safer than today.

2. Air–ground integration and autonomy

Future ATM needs to evolve, exploiting existing technologies as much as possible and developing new technologies to increase global ATM performance in terms of capacity, operational efficiency and the accommodation of new and/or more autonomous air vehicles, that is, supporting the evolving demand in terms of diversity and complexity arising from the combination of very-low-level airspace and a high density of operations. This progressive move towards autonomous flying, enabled by self-piloting technologies, requires closer integration and advanced means of communication between vehicle and infrastructure capabilities so that the infrastructure can act as a digital twin of the aircraft. Ultimately, manned and unmanned aerial vehicles should operate in a seamless and safe environment using common infrastructure and services supporting a common concept of trajectory-based operations (TBOs). Future operations should therefore rely on direct interactions between air and ground automation, with the human role focused on strategic decision-making while monitoring automation.

Expected impact. The air–ground integration supported by automation levels 2/3 and then 4/5 will enable the implementation of target architecture and transformation to TBOs (ATM Master Plan phases C and D). In particular, the integration of certified drones into all classes of airspace will be achieved thanks to increased automation and the delegation of separation responsibility to systems. In addition to full U-space services, single pilot operations will be rendered possible.

3. Capacity on demand and dynamic airspace

In recent decades, capacity has not been available when and where it was needed and it has often been available when and where it was not needed. New airspace users, including remotely piloted aircraft system (RPAS) and high-altitude operations (HAOs) traffic, will increase by 2030 and will require an increased level and variability of capacity. Integrated ATM requires agility and flexibility in providing capacity where and when it is needed, particularly for maximising the use and performance of limited resources (i.e. airspace and ATC operators (ATCOs)). It will require the dynamic reconfiguration of resources and new capacity-on-demand services to maintain safe, resilient, smooth and efficient air transport operations while allowing for the optimisation of trajectories even during busy periods.

Expected impact. By providing capacity dynamically where and when it is needed and reconfiguring the airspace to match the traffic flows, overall system resilience and flexibility will be increased significantly. Predictability (from an airline- and airport-scheduling perspective) is ensured by a more stable and predictable level of capacity in all-weather operations.

Peak runway throughput increases could deliver improved exploitation of airports in terms of both airport slot increases (in the scheduling phase) and on-time operations.

The optimisation of trajectories helps to reduce fuel-burn and increases predictability, contributing to flight efficiency, reducing the environmental impact and enhancing the passenger experience.

The establishment of the common network performance cockpit, following the definition of appropriate key performance areas (KPAs) for the performance of the airspace, will allow an increased level of connectivity, providing new opportunities for revenue generation and creating new opportunities for business cooperation between European regions.

An increased level of ATCO productivity will make it possible to manage traffic growth with the current level of resources, thus improving cost-efficiency.

4. U-space and urban air mobility

Over the next 10 years, through the implementation of the SRIA, the aim is to unlock the potential of the drone economy and enable urban air mobility (UAM) on a wide scale. To that end, a new ATM concept for low-altitude operations needs to be put in place to cater safely for the unprecedented complexity and high volume of the operations that are expected. This concept, referred to as U-space, will include new digital services and operational procedures, and its development was already started within the SESAR 2020 programme. U-space is expected to provide the means to safely and efficiently manage high-density traffic at low altitudes involving heterogeneous vehicles (small unmanned aerial vehicles, electric vertical take-off and landing (VTOL) vehicles and conventional manned aircraft), including operations in overpopulated areas and within controlled airspace. U-space will have to integrate seamlessly with the ATM system to ensure safe and fair access to airspace for all airspace users, including UAM flights departing from airports.

Expected impact. The assumption made in the 2020 edition of the European ATM Master Plan is that the coordinated development and deployment of U-space is key to realising in a timely manner the economic benefits anticipated in the 2016 European drones outlook study. In addition, the assumption is that U-space will not have a negative effect on the Master Plan performance ambitions for the European ATM system. This holds in particular for the ambitions relating to safety, security and capacity (notably at airports), as well as cost-efficiency.

Specific performance metrics for measuring the efficiency of U-space service provision need to be developed as part of the U-space R&I and will result in a specific U-space performance framework. This will not only ensure that U-space service provisions can be properly evaluated but will also enable an assessment of the additional benefits obtained through the coordinated development of such services.

5. Virtualisation and cybersecure data-sharing

The 2019 airspace architecture study ('A proposal for the future architecture of the European airspace') clearly highlighted the lack of flexibility in the sector configuration capabilities at pan-European level. This is caused by the close coupling of ATM service provision to air traffic service (ATS) systems and operational procedures, which prevents air traffic from making use of cloud-based data service provision. A more flexible use of external data services, considering data properties and access rights, will allow the infrastructure to be made more efficient, reducing the related costs. It will enable data-sharing and foster more dynamic airspace management and ATM service provision, allowing ATS units (ATSUs) to improve capacity in portions of airspace where traffic demand exceeds the available capacity. It furthermore offers options for the contingency of operations and the resilience of ATM service provision.

Expected impact. The interoperability criteria on the flight object (i.e. sharing of flight data in a consistent and widely and easily available manner, subject to appropriate access controls) will need to have reached a sufficient level of maturity to allow access to the data by all of the parties involved at any time during all flight phases, from pre-departure to on-block.

Additional connectivity measures relying on controller–pilot data link communication are available for consideration, providing a solid alternative to the very high frequency (VHF) voice communication channels.

The establishment of a fully virtualised environment will need to be coordinated with the ATCO licensing scheme and will therefore also be people-centric. The active inclusion of the ATCO and air traffic safety electronics personnel (ATSEP) communities in the development phase is a prerequisite for successful implementation. Close collaboration within and input into the EU regulatory process is required so that, where necessary, the regulations can be adapted in a timely manner to allow for deployment.

The standardisation processes conducted by the European standardisation organisations, including the European Organisation for Civil Aviation Equipment (EUROCAE), must be put in place to ensure a set of common standards.

The activities performed at European level must become a building block for the global ATM environment; therefore, close collaboration with the International Civil Aviation Organization (ICAO) is needed.

6. Multimodality and passenger experience

A significant portion of the planned door-to-door journey time is taken up by the buffers needed to absorb uncertainties associated with the performance of the various modes contributing to a journey (including within airports). Mobility providers need access to reliable planning and real-time information on schedules to give more accurate forecasts of arrival and transfer times. Optimising door-to-door mobility for people and goods is essential in meeting citizens' expectations for increasingly seamless mobility, where they can rely on the predictability of every planned door-to-door journey and can choose how to optimise it (shortest travel time, least cost, minimal environmental impact, etc.). Considering ATM to be an integrated part of an intermodal transport system will make it possible to share data between modes and to collaborate better to optimise the performance of both the overall transport system and the door-to-door journey.

Expected impact. Optimised operations as a result of improved gate-to-gate planning will contribute to the optimisation of fuel-burn and therefore of carbon dioxide (CO_2) emissions per flight. Additional environmental benefits will come from alleviating congestion at and around airports by improving passenger flows (through predictability and single ticketing), from helping access/egress to/from airports using environmentally friendly means, and from integrating vertiports for electric UAM vehicles.

Sharing data on air transport with travel service providers will help passengers plan intermodal journeys that include air segments. During such journeys, complete integration of airports as multimodal nodes within the ATM network will enable full and seamless interoperability between the surface transport network, airports and the airport operators' and Network Manager (NM) systems, contributing to increasing network resilience and the reliability and predictability of journey parameters, enhancing punctuality and passenger experience overall.

Fully integrating the most congested airports into the ATM planning process and introducing tools that allow user-driven prioritisation based on real-time multimodal passenger constraint information that is monitored and shared accurately at the network level will help reduce departure delay, while improving instrument flight rules (IFR) movement numbers at these airports and ultimately IFR network throughput.

The data-sharing-powered network performance cockpit will enable increased predictability of traffic flows coupled with increased network flexibility and resilience. This will in turn help to reduce en route congestion and air navigation service (ANS) costs. New data-sharing standards and systems will allow new 'as a service' businesses, creating more value for aviation, within an integrated transport-system.

Improved, accurate, customer-focused planning, including user-driven prioritisation, will allow operators to customise and optimise every flight, balancing their individual constraints against those of the network. This will have a direct positive impact on additional gate-to-gate flight times, fuel-burn per flight and operational costs from congestion and disruption.

There will be also a positive impact on resilience from data-sharing, increased knowledge and integrated network crisis management processes.

The better integration of unmanned aerial systems (UASs), UAM and GA operations at airports and within terminal manoeuvring areas (TMAs) will directly contribute to increased, seamless and hassle-free mobility while enhancing operational safety. Similarly, punctual, predictable and integrated ground transport to and from the airport will reduce passenger stress and contribute to reducing stress-related accidents.

7. Aviation Green Deal

The objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, requires accelerating the shift towards smarter and more sustainable mobility. This requires aviation to intensify its efforts to reduce emissions. To this end, a set of operational measures to improve the fuel efficiency of flights will have to be put in place with the aim of enabling aircraft to fly their optimum fuel-efficient four-dimensional (4D) trajectory. At the same time, to ensure sustainable air traffic growth, it is necessary to speed up the modernisation of the air infrastructure to provide more capability and capacity, making it more resilient to future traffic demands and adaptable through more flexible ATM procedures. Furthermore, reducing the impacts of aircraft noise and improving air quality will remain a priority around airports.

Expected impact. Not splitting sectors further and increasing capacity will enable optimal flight trajectories, providing important fuel efficiencies and thus reductions in CO_2 emissions. Innovative approaches such as formation flights will bring additional fuel savings.

A high level of automation will make it possible to go beyond the current limits of sector capacity due to controller workload, which will allow optimal and environmentally friendly flight trajectories. This will also have significant benefits in terms of productivity gains and will remove limitations related to sector and controller workload. In addition, minimising fuel consumption by airspace users will reduce CO_2 emissions and the related costs of emissions allowances.

A high level of automation will also ensure that safety levels are maintained or improved, with the greatest benefit being at the highest level of automation. An intermediate level of automation, whereby humans are kept in the loop, might be delicate and would not necessarily bring the best safety benefits. It is suggested that automation be initially started at night, in oceanic or low-density airspace, to gain experience.

8. Artificial intelligence for aviation

Artificial intelligence (AI) is one of the main enablers for overcoming the current limitations in the ATM system. A new field of opportunities arises from the general introduction of AI, enabling higher levels of automation and affecting the ATM system in different ways. AI can identify patterns in complex real-world data that human and conventional computer-assisted analyses struggle to identify. It can also identify events and provide support for decision-making, and even optimisation.

Over recent years, developments in and applications of AI have shown that it is a key ally in overcoming these present-day limitations, as in other domains. Tomorrow's aviation infrastructure will be more data-intensive and, thanks to the application of machine learning (ML), deep learning and big data analytics, aviation practitioners will be able to design an ATM system that is smarter and safer, by constantly analysing and learning from the ATM ecosystem.

Expected impact. AI will enable the optimisation of aircraft trajectories, allowing a potential reduction in the aviation environmental footprint. It will also play a fundamental role in aviation/ATM to address airspace capacity shortages, enabling dynamic configuration of the airspace and allowing dynamic spacing separation between aircrafts. Furthermore, AI will enrich aviation datasets with new types of datasets, unlocking air/ground AI-based applications, fostering data-sharing and building up an inclusive AI aviation–ATM partnership. This will support decision-makers, pilots, air traffic controllers and other stakeholders, bringing benefits in cost-efficiency by increasing ATCO productivity (reducing workloads and increasing complexity capabilities).

Increasing predictability will be a key role for AI, by enabling traffic predictions and forecasts that will boost punctuality. Safety science will also need to evolve to cope with the safety challenges posed by the introduction of ML.

Finally, actual safety levels will be at least maintained if not improved using this technology, and AI will offer the possibility to stay cyber-resilient to new technologies and threats; the objective is to maintain a high level of security.

9. Civil/military interoperability and coordination

The digital transformation of the European ATM network will have an impact on both civil and military aviation and ATM operations. Care must be taken to ensure a sufficient level of civil/military interoperability and coordination, especially concerning trajectory and airspace information exchange, as well as the use of interoperable communications, navigation and surveillance (CNS) technologies. Therefore, a joint and cooperative civil–military approach to ATM modernisation would be the best choice to achieve the appropriate level of interoperability, including maximising synergies between civil and military research and development activities.

Expected impact. Civil/military interoperability and coordination will make direct contributions to military mission effectiveness through improved collaborative decision-making (CDM) in the mission planning phase, increased adherence to planned trajectories, the accommodation of unpredictable and complex mission profiles, and enriched surveillance and threat detection at a reasonable cost.

Such activities will also make indirect contributions to the European network's performance in terms of safety, predictability, capacity, flight efficiency and reductions in CO_2 emissions for all operational stakeholders, resulting in particular from a common civil/military approach in defining the European ATM network evolution that respects the national and collective defence requirements.

The related military ambition is to execute missions as required. Achieving higher congruence between mission planning and execution leads to greater mission effectiveness and the improved predictability of 4D mission trajectories.

2.1.1 Implementing the flagships

As a part of the Digital European Sky programme, these flagships and the related R&I needs will be mapped with the performance ambitions of the single European sky programme and further developed into candidate SESAR Solutions.

A number of further activities will be carried out to ensure coherence in the developments across the individual projects. These are the so-called transversal activities of architecture, master planning, performance management and preparation for standardisation. As part of the SESAR 3 JU programme management activities, these activities contribute to the overall framework that will make the Digital European Sky programme not just a list of disconnected projects but a coherent programme, delivering solutions that are aligned at the content level with the direction set by the SRIA and the ambition in the European ATM Master Plan.

2.2 SESAR research and innovation pipeline

For the Digital European Sky programme, the pipeline is constructed from four categories of activities; categories 2 and 3 are within the industrial research phase ([6]):

1. Exploratory Research (technology readiness levels (TRLs) 0–2), funded under Horizon Europe for the EU part;
2. Industrial Research and Validation (TRLs 3–6), funded under Horizon Europe for the EU part;
3. Fast-Track Innovation and Uptake (TRLs 2–7), funded under Horizon Europe for the EU part;
4. Digital Sky Demonstrators (TRL7 and TRL8), funded under the Connecting Europe Facility (CEF) for the EU part ([7]), in collaboration with CINEA.

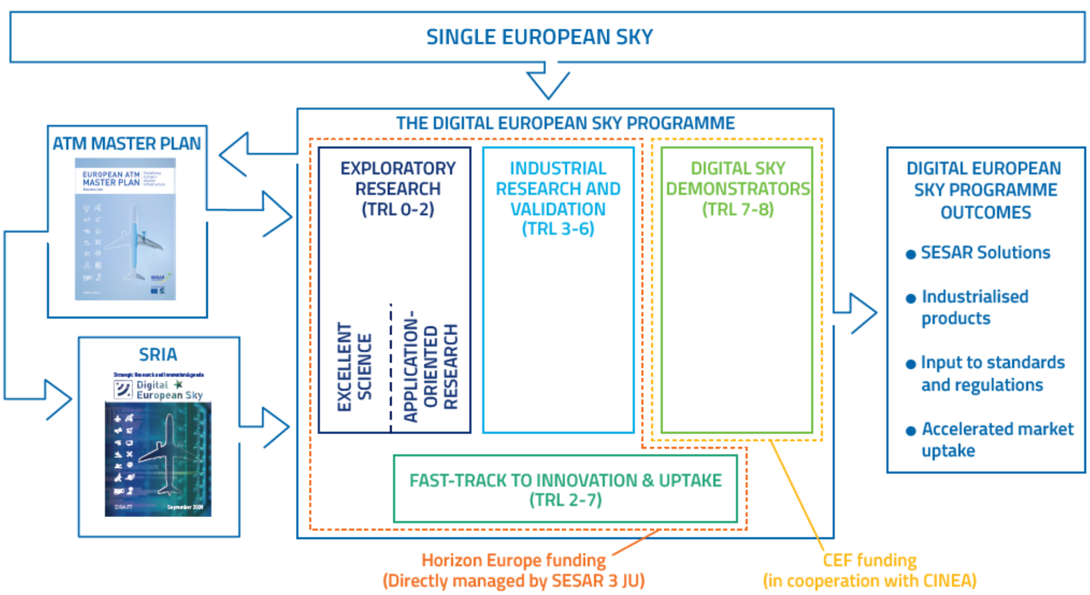

Figure 1: The SESAR innovation pipeline

The four categories of activity, including their full scope, are shown in Figure 1 and are further described in Chapter II. They enable a best-practice managed approach that is suited to the needs of the SESAR R&I activities to be performed and is at the applicable level of research maturity. The innovation pipeline allows for both a more traditional 'waterfall' development method and iterative

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([6]) The indicated source of funding is further detailed in Chapter II, Sections 2.2.3, 2.2.3.3 and 4.

([7]) Within the Digital European Sky programme, Digital Sky Demonstrators are subject to a specific working arrangement. In this arrangement, the SESAR 3 JU ensures the strategic orientation of the projects and provides technical advice to the European Commission, in coordination with the European Climate, Infrastructure and Environment Executive Agency (CINEA), which manages the calls for proposals and the resulting grants.

developments and is primarily focused on 'fast-track innovation and uptake'. The innovation pipeline will make it possible to rapidly transition from exploration (low TRL) to validation, thus enabling accelerated progression to demonstration (high TRL) and transition to the market.

3 Strategy for the implementation of the programme

For the period of reference (2022–2023), the priority is to complete the SESAR 2020 programme and to ramp up the Digital European Sky programme to ensure the timely delivery of expected SESAR solutions.

The Digital European Sky programme is delivered using a range of instruments under Horizon Europe for both the exploratory research and the industrial research activities, while the Digital Sky Demonstrators are secured using the CEF financing framework.

Under the Digital European Sky programme, there will be three types of calls for proposals covering three R&I phases: (1) exploratory research calls with Horizon Europe funding, (2) industrial research and validation, also covering fast-track innovation and uptake, with Horizon Europe funding, and (3) Digital Sky Demonstrators with CEF funding managed by CINEA in close cooperation with the SESAR 3 JU.

Four calls for proposals are planned for the **Exploratory Research** phase. The first call for exploratory research is to be published in early Q2 2022 to allow the launch of the first exploratory research projects in Q2 2023. The subsequent calls will be scheduled in a way that allows the proposed exploratory research content described in the MAWP to be completed. The proposed duration of the exploratory research projects is 2.5 years, including a 6-month period at the end of their life cycle for carrying out communication, dissemination and exploitation activities (as recommended by the SESAR 2020 Scientific Committee, established in accordance with Article 154 of the Single Basic Act. The duration of the projects under the last exploratory research call will be limited to 2 years to secure the closure procedure of the Digital European Sky programme and the SESAR 3 JU by the end of 2031.

Three calls for proposals are planned for the **Industrial Research and Validation** phase, also covering Fast-track Innovation and Uptake. Like the exploratory phase, the first industrial research call is also planned to be published in early Q2 2022, allowing the launch of the first industrial research projects in Q2 2023. The first industrial research call will be synchronised with the first exploratory research call in order to optimise their management (e.g. call publication, evaluation and grant agreement preparation activities) and resource allocation. Three waves of calls for proposals will be organised, with each intended to make significant steps towards the achievement of the specific objectives of the SESAR 3 JU and performed in a manner similar to that of the SESAR 2020 programme. This will also support ongoing feedback for the European ATM Master Plan, standards development and the identification of needs for future regulation. The proposed duration of industrial research projects is 3 years, except for the final industrial research call, which will have a limited duration of 2 years to secure the closure procedure of the Digital European Sky programme and the SESAR 3 JU by the end of 2031.

For **Digital Sky Demonstrators**, a first call was launched by CINEA at the end of Q3 2021. Subject to the signing of a contribution agreement between the SESAR 3 JU and the Commission and of a specific working arrangement established between the SESAR 3 JU and CINEA, the SESAR 3 JU will ensure the strategic orientation of this call for proposals and support the management of resulting grants through technical expertise during the call evaluation and grant management phases. A second call for proposals for Digital Sky Demonstrators is planned to be launched in Q3 2022.

Chapter II – Biannual work programme for 2022–2023

1 Executive summary

Introduction

The SESAR 3 JU builds on the work and achievements of earlier SESAR research and innovation programmes (SESAR 1 and SESAR 2020), but seeks to accelerate the market uptake of innovative solutions through a portfolio of demonstrators and a fast-track mechanism. The partnership will provide a catalyst for speeding up the transition towards a green, climate neutral and digital Europe, and for making European industry more resilient and competitive.

The SESAR 3 JU's Bi-Annual Work Programme 2022–2023 sets out the remaining research and innovation activities within the context of SESAR 2020, while also detailing the priorities and plans for SESAR 3 JU, including the launch of its Digital European Sky programme of R&I and related calls.

Operational activities

Specifically, the following operational activities are planned over the course of 2022 and 2023.

SESAR 2020 programme

- Supervision of ongoing projects under the exploratory research (ER) open call for proposals (ER4 (H2020-SESAR-2019-2)), management of related grant agreements and closure of these grants.
- Supervision of ongoing projects under the industrial research and validation (IR) and very-large-scale demonstration (VLD) restricted calls for proposals (IR-VLD wave 2 (H2020-SESAR-2019-1) and IR-VLD wave 3 (H2020-SESAR-2020-2)), management of related grant agreements and closure of these grants.
- Completion of release 11 in line with the plan published in 2020 and execution of release 12 based on the plan published at the end of 2021.
- Supervision of ongoing projects under the open call for proposals (VLD Open 2 (H2020-SESAR-2020-1)), management of related grant agreements and closure of these grants.

Digital European Sky programme

- Follow-up of activities as outlined in the European ATM Master Plan (2020 edition) and in particular in levels 2 and 3 (the 'implementation view').
- Launch of the HORIZON-SESAR-2022-DES-ER-01 (S3 ER1) call, evaluation of the proposals and signing of awarded grants.
- Launch of the HORIZON-SESAR-2023-DES-ER-02 (S3 ER2) call and initiation of the evaluation of the proposals.
- Launch of the HORIZON-SESAR-2022-DES-IR-01 (S3 IR1) call, evaluation of the proposals and signing of awarded grants.
- Provision of technical expertise to the EU-RAIL – SESAR Synergy call for proposals (HORIZON-ER-JU-2023-FA1-SESAR) under the Horizon Europe programme with Europe's Rail Joint Undertaking (EU-Rail).

- Provision of technical expertise to CINEA in support of the call evaluation relating to SESAR Digital Sky Demonstrators (DSDs; CEF-T-2021-SIMOBGEN) and for the technical monitoring of awarded grants.
- Provision of expertise to CINEA for the technical specifications in support of the second CEF call (CEF-T-2022-SIMOBGEN) addressing the SESAR DSDs to be launched in September 2022, followed by the technical contribution to the evaluation.
- Provision of expertise to CINEA for the technical specifications in support of the third CEF call (CEF-T-2023-SIMOBGEN) addressing the SESAR DSDs to be launched in September 2023.
- Planning and management of procurement services to provide the JU with the necessary support.

These activities will be underpinned by synergies with partners and initiatives across Horizon Europe and CINEA, and major national (sectorial) policies, programmes and activities, as well as outreach and engagement with key civil and military aviation stakeholders beyond the membership of the SESAR 3 JU. At the same time, the SESAR 3 JU will work with third countries and/or international organisations to ensure global interoperability and harmonisation.

Support to operations

Over 2022 and 2023, the SESAR 3 JU will carry out a range of corporate and back-end services to support the aforementioned operational activities. These services will be carried out efficiently and effectively in line with best practices, standards and applicable regulatory frameworks.

The following are just some of the support activities planned over the course of 2022 and 2023:

- promoting the SESAR 3 JU partnership and showcasing 2020 results through events, publications and digital media; familiarising audiences with the flagship areas of work; enlarged membership and partnership; and targeting stakeholder and generalist audiences both in Europe and worldwide;
- providing guidance to members and projects (beneficiaries) and monitoring their compliance with obligations and commitments to communicate, disseminate and exploit project outcomes within the framework of the partnership, Horizon 2020 and Horizon Europe;
- ensuring the effective and efficient financial, administrative, legal and corporate management of the SESAR 3 JU through the implementation of internal control principles and systematic quality assurance activities, as well as synergies, where applicable, with the European Organisation for the Safety of Air Navigation (EUROCONTROL) on back-office functions.

The SESAR 3 JU will rely on its governance structure to ensure the strategic orientation and effective supervision of its operations and support activities. In 2022 and 2023, the SESAR 3 JU will provide secretariat support to the Governing Board to ensure effective and timely decision-making. At the same time, the SESAR 3 JU will also provide secretariat support for the establishment and operation of the States' Representatives Group and Scientific Committee, as well as operational committees, ensuring that the necessary procedures and support structures are put in place.

2 Operational activities of the SESAR 3 Joint Undertaking for 2022–2023

2.1 Scientific priorities, challenges and expected impacts

The R&I priorities of the SESAR 3 JU are described in Chapter II, Section 1.2of the MAWP. In 2022 and 2023, the SESAR 3 JU will complete the closure of the SESAR 2020 programme and start the implementation of the Digital European Sky programme with the launch of three calls for proposals, two in exploratory research and one in industrial research and validation, with the support of CINEA for two additional calls.

2.1.1 SESAR 2020 programme

The priority of the SESAR 2020 programme is to close the programme and finalise the delivery of SESAR solutions. Figure 2 provides an overview of the portfolio of projects under the SESAR 2020 programme.

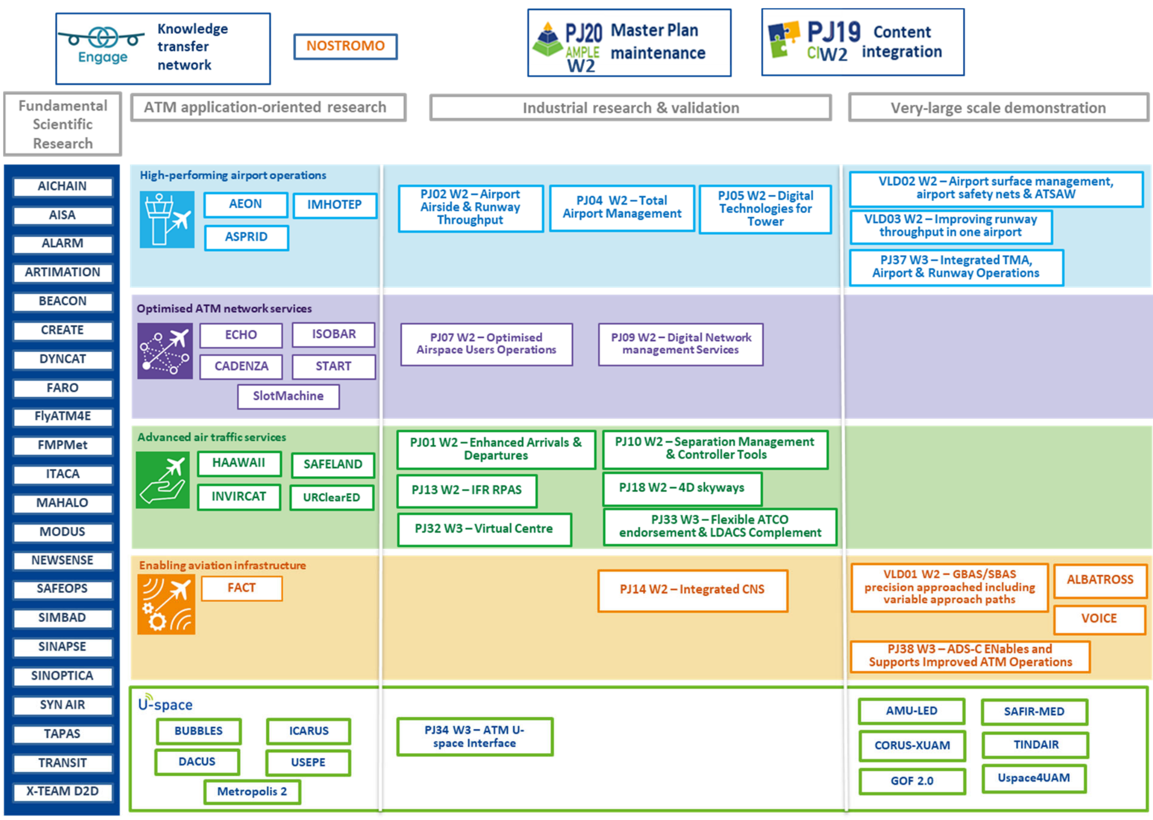


Figure 2: SESAR 2020 programme – portfolio of projects

2.1.2 Digital European Sky programme

Figure 3 presents the scope of the first set of calls for proposals under the Digital European Sky programme. In particular, it shows how the different SRIA flagships are covered across the R&I pillars. It also presents the budget allocated per work area (WA).

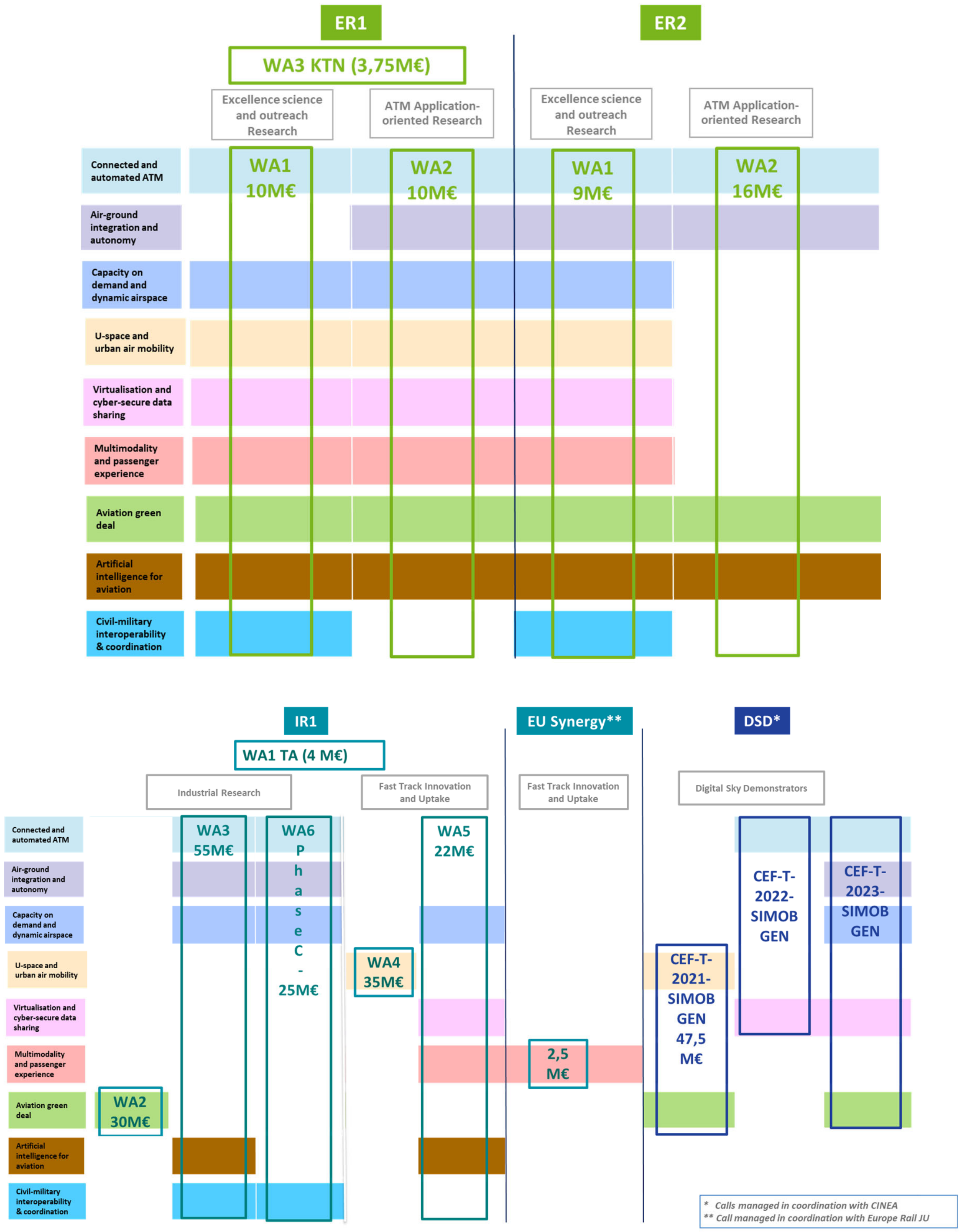


Figure 3: Scientific priorities and links with the SRIA flagships covered through the first set of calls for proposals of the Digital European Sky programme

In 2022, the SESAR 3 JU will launch two open calls for proposals under the Horizon Europe programme.

1. The open Digital European Sky ER1 call for proposals (HORIZON-SESAR-2022-DES-ER-01) will be composed of the following three work areas.
    - **WA1 (fundamental science and outreach)** comprises the exploratory research necessary to develop new concepts for ATM beyond those identified in the European ATM Master Plan, and will help to develop emerging technologies and methods to the level of maturity required to feed the applied research conducted by the SESAR 3 JU. This part of the research is structured around the same flagships identified in the rest of the programme to ensure that there is a flow of ideas and results in a structured manner across the whole programme.
    - **WA2 (ATM application-oriented research)** comprises exploratory research aiming to bridge the results of ATM excellent science and outreach and the higher maturity ATM research performed with the wider research community, as part of SESAR 3 JU industrial research activities. It also aims to provide the necessary scientific support to ATM change.
    - **WA3 (knowledge transfer network)** provides support for the SESAR 3 JU to continue maintaining the overarching view across ATM exploratory research that was established in SESAR 2020, provides a coordinated exchange of research knowledge across a wide range of relevant themes and, within the context of this networking, helps to further stimulate the future ATM skilled workforce. The challenge is to support and encourage collaborative research on future and emerging innovative ideas, expertise and knowledge for the benefit of the future evolution of the European ATM system and its people.
2. The open Digital European Sky IR1 call for proposals (HORIZON-SESAR-2022-DES-IR-01) will be composed of the following six work areas.
    - **WA1** covers transversal activities with a focus on Master Plan activities and performance management.
    - **WA2** comprises the industrial research required to achieve the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, which requires accelerating the shift towards smarter and more sustainable mobility. This requires aviation to intensify its efforts to reduce emissions, in line with the targets set out in *Flightpath 2050* ([8]).
    - **WA3** focuses on the delivery of the next generation of enabling platforms and services in view of achieving the ambition of the Digital European Sky and phase D of the European ATM Master Plan.
    - **WA4** covers fast-track innovation and uptake activities addressing U-space and UAM.
    - **WA5** covers fast-track innovation and uptake activities addressing capacity on-demand and dynamic airspace, virtualisation and cybersecure data-sharing, multimodality and passenger experience, and the aviation Green Deal.

([8]) *Flightpath 2050* is a report of the High Level Group on Aviation and Aeronautics Research established by the European Commission in December 2010, which sets out a new vision for the aviation sector to be achieved by 2050.

- **WA6** comprises the industrial research activities required to complete TRL6 for the key research and development (R&D) solutions that define the European ATM Master Plan phase C ambition, establishing a solid foundation for ATM Master Plan phase D. The scope of this work area includes a number of elements that, although addressed in SESAR 2020 wave 1 and 2 activities, did not lead to the completion of TRL6. It also covers the integration of solutions that, having achieved (or nearly achieved) TRL6 as part of previous SESAR programmes, still require integrated validation activities to facilitate and de-risk the industrialisation and deployment phases: these activities may target a TRL7 level of maturity. It may also include activities for the early integration of less mature SESAR Solutions.

Further detail on these two calls for proposals, including on the conditions of the calls and relative management rules, can be found in Annex II.

3. In 2023, the SESAR 3 JU will launch the open Digital European Sky ER2 call for proposals (HORIZON-SESAR-2023-DES-ER-02) that will be composed of the following two work areas.

   WA1 Excellence science and outreach Research, which will cover all R&I flagships. WA1 will also call for innovative or unconventional concepts supporting the following policy topics for the development of ATM systems within and beyond the Digital European Sky:

   - Enhancing the role of SESAR as an enabler for the implementation of the single European sky. Projects should aim at better integrating the SESAR innovation cycle with the performance, charging and network management pillars of the single European sky. The objective is also to develop ideas on how the single sky charging scheme can be used to incentivise early adopters of SESAR solutions contributing to the Union-wide performance objectives and to the greening of aviation.

   - Improving ATM's contribution to the Union's green transition strategies, namely by enabling synergies and complementarities between the transport, energy and digital sectors.

   WA2 ATM application oriented Research, which will focus on 4 flagships for de-risking the delivery of ATM MP Phase D:

   - **Connected and automated ATM**;
   - **Air–ground integration and autonomy;**
   - **Aviation green deal**;
   - **Artificial Intelligence for aviation**.

   NB: Regarding the five flagships not included in WA2:

   - **U-space and urban air mobility** and **Multimodality and passengers experience**: can be better addressed by IR fast-tracks;
   - **Capacity on demand and dynamic airspace**: a significant research effort is already done by NM and in IR;
   - **Civil-military interoperability & coordination**: better focus on excellence science to define a list of applications to be included in ER-03;
   - **Virtualization and cybersecurity data-sharing**: the content is already fairly well covered by todays IR and DSD calls.

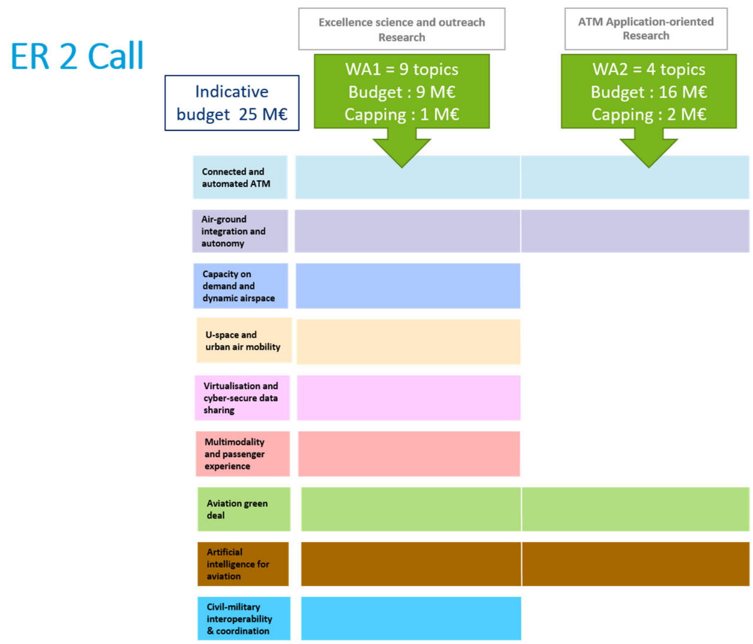


Figure 4: Scientific priorities and links with the SRIA flagships covered through the ER2 calls for proposals of the Digital European Sky programme

A second call for proposals for DSDs (CEF-T-2022 SIMOBGEN) is also planned to be launched in September 2022, funded under the CEF programme and containing provisions for the following two SESAR 3 JU digital European Sky Demonstrators: (1) Connected & Automated ATM and (2) Virtualisation and cyber-secure data sharing. More specifically, the DSD projects focus on the gradual transition towards higher levels of automation and on the virtual centres and ATM data service providers.

A third call for proposal for DSDs (CEF-T-2023 SIMOBGEN) is also planned to be launched in September 2023, funded under CEF programme. The call will contain provisions for establishing Europe as the most efficient and environmentally friendly sky to fly in the world. The demonstrators will contribute to achieving the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement. The call will also enable a more flexible, scalable, resilient, safe and secure ATM that can withstand disruptions in the aviation system through a phased but substantial progress on the deployment of the future European airspace architecture (Airspace Architecture Study Transition Plan (AAS TP)) and contribute to the digital transformation of air navigation service provision.

In 2023, the SESAR 3 JU will seek to put in place measures to maximise its impact in particular through a joint EU-RAIL – SESAR Synergy call for proposals under the Horizon Europe programme with the EU-Rail and in consistency with the expectations laid down in the Single Basic Act. The aim is to address common sectorial issues such as multimodality transport. Indeed, aviation and railway are integral parts of the intermodal transport ecosystem expected to optimise door-to-door mobility for people. It will allow contributing to the optimisation of fuel-burn and therefore reductions of CO_2 emissions per journey. Additional environmental benefits (i.e. emissions, noise and/or local air quality) will come from alleviating congestion at and around airports / railway stations by improving passenger flows. To successfully address these objectives and improve the attractiveness of combined air-rail travel for passengers, the following research elements should be addressed:

- Integration of aviation and railway transport modes with the development of tools, digital platforms and services for a better integration of aviation and railway transport modes, as part of an intermodal transport ecosystem;
- ATM-airport-railway collaborative decision making (CDM) process. This enables collaborative decision-making involving both air transport and railway transport stakeholders with the aim of facilitating a more efficient strategic and tactical planning and management of intermodal operations, passenger flows and enhancing passenger experience between the two modes of transportation
- An integrated aviation-railway transport network crisis management process to enable the coordination – when managing a crisis – between air and railway transport modes and a multitude of actors, including local and national authorities' representatives.

2.2 Objectives, indicators and activities

2.2.1 Strategic area of operation 1: Provide strategic steering to the SESAR 2020 programme and the Digital European Sky programme

2.2.1.1 *SESAR 2020 programme*

Under the leadership of the SESAR 3 JU, all SESAR R&I activities are undertaken under a common framework. This framework is mainly applicable to industrial research and validation and to Digital Sky Demonstrators activities and relies on the following elements:

- maintenance of the European ATM Master Plan;
- content integration activities aiming for transversal steering of the programme through the concept of operations, architecture activities and the performance framework;
- system engineering support activities aiming to create traceability and coverage reports between high-level concept and operational requirements, with requirements, validation objectives and validation results at the level of solution development.

In 2022 and 2023, the following projects will support the execution of this framework: PJ20 W2, 'Master Plan maintenance', covering the maintenance of the European ATM Master Plan, and PJ19 W2, 'content integration', covering the required coordination of industrial research and validation projects to address the architecture, the performance and alignment with the European ATM Master Plan.

Furthermore, based on the outcome of the last SESAR 2020 Master Plan Committee, all ATM stakeholders came together to develop an action plan composed of three practical improvement packages that, if implemented successfully, will significantly simplify and strengthen the Master Plan process. The scope of the action plan is to help direct the successful design of future changes to the Master Plan process, providing a clear set of goals, actions and success criteria for each proposed improvement package. The oversight of the successful implementation of this action plan is proposed to be ensured by the SESAR 3 JU Governing Board.

The future Master Plan process is proposed to exclusively focus on strategic planning and monitoring of the execution of the SESAR project (i.e. both development and deployment). This implies that the outputs of the Master Plan process will exclusively be tailored to the needs of an audience of public (including Member States) and private decision-makers. By contrast, in the past, it targeted a much wider audience (covering both decision-makers and experts without fully satisfying either). The future Master Plan process will also provide a more robust outlook on the network performance impact that could be gained through the roll-out of SESAR across all implementing bodies than it ever did in the past.

In areas in which the SESAR 3 JU does not have executive powers (e.g. the execution of rule-making or standardisation plans or the deployment programme for common projects), the principle of subsidiarity will be applied more strictly. In this way, the European ATM Master Plan will continue to be recognised as the unique and official strategic reference point for ATM modernisation efforts in Europe, with supporting planning details being left to be handled by the organisation in charge of execution. In particular, in the area of SESAR deployment and within the boundaries of the EU regulatory obligations and tasks of each entity, special attention will be paid to the unification of processes between the SESAR 3 JU, EUROCONTROL (such as European and local single sky implementation) and the deployment manager and to preserving the strategic value of the Master Plan while also connecting this with actual deployment activities that are taking or have taken place.

The SESAR 3 JU Governing Board members will benefit from a lower administrative burden, as formal approvals for changes to the European ATM Master Plan will be limited to multi-annual update cycles (typically every 3–4 years) unless requested otherwise by the Governing Board. This will enable a full synchronisation of formal adoption cycles between the EU, EUROCONTROL and private representatives of the Governing Board. By extension, this should also enable a much more solid buy-in from Member States, which will in turn play a more direct role in the implementation of activities of the SESAR 3 JU via the States' Representatives Group.

In addition, the Governing Board members will be provided (for information) on an annual basis with information showing the strategic alignment of SESAR development and deployment activities with the strategic vision and direction outlined in the European ATM Master Plan in a format that can also be used to stimulate corrective actions where and when appropriate.

The improvements are proposed to be gradually implemented from 2022 and completed in time for the next update of the Master Plan.

In addition, transversal activities in the exploratory research area will continue with the NOSTROMO project, which aims to develop new approaches to ATM performance modelling, and with the ENGAGE project, which provides the knowledge transfer network.

The strategic steering activities are performed in close coordination with the programme management activities to provide an additional level of integration to de-risk the delivery of candidate SESAR solutions.

Project reference	Project title	Short project description	Call for proposals	Status (at the beginning of 2021)	Maximum grant amount (EUR)

PJ19 W2	Content integration	Content integration activities aim to coordinate and integrate operational and technical solutions, and as such to support and guide the processes to ensure their completeness, consistency and coherency from a holistic perspective as expressed in the SESAR concept of operations	H2020-SESAR2019-1	Ongoing from 2020 to 2022	4 473 969
PJ20 W2	Master Plan maintenance	The European ATM Master Plan has three levels (executive, planning and implementation), which require synchronised monitoring and alignment. The work consists in maintaining, updating and publishing the master plan as and when necessary, and in managing the Master Plan update campaigns	H2020-SESAR2019-1	Ongoing from 2020 to 2022	2 011 278
NOSTROMO	Next-generation open-source tools for ATM performance modelling and optimisation	The ATM system is composed of elements that interact with each other generating a number of properties characteristic of complex adaptive systems. NOSTROMO aims to develop new approaches to ATM performance modelling that are able to reconcile model transparency, computational tractability and ease of use with the necessary sophistication required for a realistic representation of the ATM system	H2020-SESAR2019-2	Ongoing from 2020 to 2022	1 771 361
One transversal project (Engage), which addresses the knowledge transfer network under the open ER3 call (H2020-SESAR-2016-1) is expected to be completed by the end of June 2022 (as a result of a grant duration extension)					

Table 2: SESAR 2020 programme transversal and strategic steering activities with related co-financing

The SESAR 3 JU has set up an external support contract to help in steering the SESAR 2020 programme, namely the SESAR development support services contract, covering industrial support, programme management support and the provision of a collaborative programme management platform until the end of December 2022.

2.2.1.2 *Digital European Sky programme*

The main activities will cover the finalisation of the call material, focusing on the transversal activities and the publication of the SESAR 3 JU IR1 call (HORIZON-SESAR-2022-DES-IR-01). Following the call deadline, the proposals received will be evaluated according to the award criteria. The selected proposals will initiate their grant preparation phase, which will be concluded by the signing of the grants and the initiation of the execution of the projects. Considering the huge number of new founding members, who are not familiar with the needs and details of the transversal activities of the SESAR R&I programme, and considering the potential cost in terms of their learning curve on ramping up and executing these activities, in particular on content integration and architecture modelling, the SESAR 3 JU transversal activities will initially focus on master planning and on performance management (both activities are further described in Annex III, Section 1.2.4.1). In the meantime, an assessment of content integration and architecture modelling tasks is under review and, before becoming applicable, these will be validated within a few projects first. Subject to the positive outcomes of the pilot, these transversal activities will be further initiated.

2.2.1.3 *Objectives, activities, indicators and targets*

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 2020	Supervise and close the transversal activities (Engage, NOSTROMO, PJ19 W2 and PJ20 W2)	Execution of the Horizon 2020 reporting and payment process	Percentage of transversal activities with project review completed	100 %	n/a
		Execution of the final Horizon 2020 reporting and payment process	Percentage of transversal activities that have submitted their final Horizon 2020 technical and financial reports	25%	100%
Digital European Sky	Launch of call HORIZON-SESAR-2022-DES-IR-01 (S3 IR1) and evaluation of the transversal projects proposals	Run the call for proposals and evaluation procedure	Evaluation report prepared in view of its submission to the Executive Director	n/a	100 %
		Run the grant preparation phase	Grant agreement preparation and signing completed	n/a	100 %
	Supervise transversal projects (under call for proposals HORIZON-SESAR-2022-DES-IR-01)	Ramping up of the projects	Percentage of IR1 projects that have their project management plans approved	n/a	100 %

Table 3: Objectives, activities, indicators and targets for strategic steering activities in 2022 and 2023

2.2.2 Strategic area of operation 2: Deliver exploratory research

2.2.2.1 *SESAR 2020 programme*

As outlined in the SESAR 2020 programme, exploratory research topics are all essential and integral components of the R&I scope funded and managed by the SESAR 3 JU. These activities are structured around three key areas.

- There is one transversal area, the **knowledge transfer network**, which aims to assess and coordinate project results to contribute to spotting innovative ideas, concepts and models that can support the identification of ATM system concept trade-offs, new technology validation at system level, and defining and consolidating requirements. The ATM research community will be able to share research results.
- There are two research areas, which have the following characteristics.
    - **ATM excellent science and outreach.** The 22 projects help in developing new concepts for ATM beyond those identified in the European ATM Master Plan, and will help to

develop emerging technologies and methods to the level of maturity required to feed into the applied research conducted by the JU. This area of exploratory research is structured around the four key features and the transversal needs of the programme to ensure there is a flow of ideas and results in a structured manner across the whole programme. The domains of research cover:

- automation and autonomy,
- complexity, data science and information management,
- environment and meteorology for ATM,
- performance, economics, legal and regulation,
- ATM's role in intermodal transport,
- CNS for ATM.

- **ATM application-oriented research.** The 18 ([9]) projects aim to link the results of ATM excellent science and outreach with the higher maturity ATM research performed with the wider research community, as part of the JU industrial research activities. The projects also aim to provide the necessary scientific support for ATM change. There is also a particular focus on bringing the ATM capacity to the level required to comply with the expected traffic growth, either directly or through connection to further funded research areas in other disciplines or sectors.

All ER4 projects are expected to close by the end of 2022. By the end of 2021, the SESAR 2020 programme included the projects set out in Table 4 as a result of the ER4 call.

Project reference	Project title	Short project description	Maximum grant amount (EUR)
AEON	Advanced engine-off navigation	AEON aims to define a concept of operations focusing on engine-off taxiing techniques, and a set of dedicated tools to support the operators. The project defines how to determine, in real time, efficient and conflict-free routing plans for autonomous and non-autonomous aircraft taxiing from gates to the corresponding runways and vice versa	1 444 525
AICHAIN	A platform for privacy preserving federated ML using blockchain to enable operational improvements in ATM	AICHAIN proposes an innovative digital information management concept combining federated ML and blockchain technologies. This enables the cybersecured exploitation of large private datasets by a privacy-preserving federated learning architecture in which neither the training data nor the training model needs to be exposed	996 505
AISA	AI situational awareness foundation for	To implement advanced automation, AI and humans need to be able to share situational awareness. Therefore, the AISA project is	990 125

([9]) One project, NOSTROMO, funded through the ER 4 call for proposals, supports strategic steering activities. Therefore, it is not included in this list and the relavant details are described in Section 2.2.1.1 of this chapter.

	advancing automation	exploring the effect of, and opportunities for, distributed human–machine situational awareness in en route ATC operations. The project is developing an intelligent situationally aware system by combining ML with a reasoning engine	
ALARM	Multi-hazard monitoring and early warning system	ALARM aims to develop a prototype global multi-hazard monitoring and early warning system. A global multi-hazard monitoring involves near-real-time and continuous global Earth observations from satellite, with the objectives being to generate prompt alerts of natural hazards affecting ATM and to provide information for enhancing situational awareness and providing resilience in crisis	991 269
ARTIMATION	Transparent AI and automation to ATM systems	ARTIMATION aims to investigate AI methods in predicting air transportation traffic and optimising traffic flows based on explainable AI to address the challenge related to the transparency of an automated system in the ATM domain. ARTIMATION will provide a proof-of-concept for transparent AI models that includes visualisation, explanation and generalisation to ensure safe and reliable decision support	999 375
ASPRID	Airport system protection from intruding drones	ASPRID aims to assess the problem of protecting airport operations from drone intrusion (careless or malicious) under a holistic and operationally oriented approach. The project proposes to investigate the vulnerability of airports under the different types of threat and the possible ways of responding, as well as to study the interrelations between all of those aspects involving different scenarios	1 235 195
BEACON	Behavioural economics for ATM concepts	BEACON aims to study the feasibility of extending the user-driven prioritisation process (UDPP) to allow multi-prioritisation processes in the airspace and the exchange of slots between airlines. It will build two models: a strategic model and a detailed tactical simulator. BEACON will make use of behavioural economics to capture the agents' behaviours properly	996 594
BUBBLES	Defining the building basic blocks for a U-space separation management service	BUBBLES aims to formulate and validate the concept of a U-space advanced (U3) 'separation management service'. It will develop algorithms to compute the collision risk of UASs, allowing separation minima and methods to be defined so that a safety level stated In terms of overall probability of collision can be defined and maintained	1 606 109

CADENZA	Advanced capacity and demand management for European network performance optimisation	CADENZA aims to develop a detailed trajectory broker concept for the European network, incorporating advanced demand–capacity balancing mechanisms. The trajectory broker will balance capacity and demand through a coordinated capacity provision process and collaborative trajectory management (including a novel trajectory-charging scheme). Significant improvements in cost-efficiency and delay are expected	1 158 124
CREATE	Innovative operations and climate and weather models to improve ATM resilience and reduce impacts	Air operations largely use weather information to make the air traffic flow safe, continuous and efficient. As climate changes continue, the information available on the weather at short and longer notice is increasing and technology is being improved. CREATE aims to achieve innovative procedures in ATM to reduce the climate and environmental impact, while becoming more resilient to weather phenomena	998 165
DACUS	Demand and capacity optimisation in U-space	DACUS aims to develop a service-oriented demand and capacity balancing process for drone traffic management. This overall objective responds to an operational and technical need in European drone operations for a tangible solution integrating the functionalities of SESAR's U-space services for traffic management to produce timely, efficient and safe decisions	1 739 618
DYNCAT	Dynamic configuration adjustment in the TMA	DYNCAT aims to enable more environmentally friendly and more predictable flight profiles in the TMA, namely on approach, by supporting pilots in configuration management	989 299
ECHO	European concept of operations for higher airspace operations	ECHO aims to deliver a comprehensive demand analysis and innovative and feasible concept of operations enabling near-term and future higher airspace operations in a safe and orderly manner. The higher airspace including the operators forms a new, almost legacy-free environment enabling an expeditions uptake of innovations or extrapolated SESAR Solutions	1 968 865
FACT	Future all-aviation CNS technology	FACT aims to increase safety, security, efficiency and robustness of the future air traffic environment through the development of integrated CNS functional architecture supporting the use of a common performance-based approach, addressing the needs of a large spectrum of airspace users across varied operational environments	1 850 500
FARO	Safety and resilience	FARO aims to bring new insights into safety and resilience in ATM, with four objectives: to exploit existing safety knowledge, to	999 559

	guidelines for aviation	quantify the impact of increasing automation on ATM safety, to analyse the impact of increasing automation on ATM resilience and to provide design guidelines and identify future research needs	
FlyATM4E	Flying ATM for the benefit of environment and climate	FlyATM4E aims to expand approved climate assessment methods and the optimisation of aircraft trajectories to identify promising mitigation options suitable for solving the task of reducing the overall climate impact of aircraft operations. The project will assess the feasibility of a concept for the environmental assessment of ATM operations working towards the environmental optimisation of air traffic operations	999 765
FMPMet	Meteorological uncertainty management for flow management positions	FMPMet aims to integrate meteorological forecast uncertainty information into the decision-making process for flow management positions. FMPMet aims to provide flow management positions with an intuitive and interpretable probabilistic assessment of the impact of convective weather on the operations, up to 8 hours in advance	849 000
HAAWAII	Highly automated air traffic controller workstations with AI integration	HAAWAII aims to research and develop a reliable, error-resilient and adaptable solution to automatically transcribe voice commands issued by both air traffic controllers and pilots, and to perform proof-of-concept trials in challenging environments. In addition, the objectively estimated controllers' workload utilising digitised voice recordings of the complex London TMA will be assessed	1 825 000
ICARUS	Integrated common altitude reference system for U-space	ICARUS aims to propose an innovative solution to the challenge of the common altitude reference inside very low-level airspaces with the definition of a new U-space service and its validation in a real operational environment	1 144 588
IMHOTEP	Integrated multimodal airport operations for efficient passenger flow management	IMHOTEP aims to develop a concept of operations and a set of data analysis methods, predictive models and decision support tools that allow information-sharing, common situational awareness and real-time CDM between airports and ground transport stakeholders	1 999 805
INVIRCAT	IFR RPAS control in airports and TMA	INVIRCAT aims to create a concept of operations for RPASs in the TMA of airports, assessing it through simulations, and to draft a set of recommendations for rule-makers and standardisation bodies	1 416 055

ISOBAR	AI solutions to meteorology-based demand and capacity imbalances for network operations planning	ISOBAR aims to provide a service- and AI-based network operations plan, by integrating enhanced convective weather forecasts for predicting imbalances between capacity and demand and exploiting AI to select mitigation measures at the local and network levels in a collaborative air traffic flow and capacity management operations paradigm	1 908 798
ITACA	Incentivising technology adoption for accelerating change in ATM	ITACA aims to accelerate the development, adoption and deployment of new technologies in ATM. ITACA will develop a new set of methodologies and tools enabling the rigorous and comprehensive assessment of policies and regulations aimed at amplifying the uptake of new technologies within ATM	999 938
MAHALO	Modern ATM via human/automation learning optimisation	To answer the question of whether automation should match human behaviour or be understandable to humans, MAHALO aims to develop an individually tuned ML system to solve ATC conflicts and couple this with an enhanced en route conflict detection and resolution display. Insights will be used to define a framework to guide the design of future AI systems	997 213
Metropolis 2	Metropolis 2: A unified approach to airspace design and separation management for U-space	Metropolis 2 aims to provide the fundamentals for concrete solutions for U-space U3/U4 services that are needed to enable high-density urban aerial operations, with a unified approach to the following U-space services: strategic deconfliction, tactical deconfliction and dynamic capacity management	1 692 760
Modus	Modelling and assessing the role of air transport in an integrated, intermodal transport system	Modus analyses the performance of the overall transport system by considering the entire door-to-door journey holistically. The project identifies (future) drivers for passenger demand and supply and assesses the impact on airside and landside processes and capacities. Based on these analyses, potential solutions to meet high-level European transport objectives are proposed	998 875
NewSense	Combining simulation models and big data analytics for ATM performance analysis	NewSense aims to improve the safety and efficiency of operations primarily in secondary airports with innovative low-cost surface surveillance solutions, based on 5G cellular networks for the long term, and millimetre-wave radar for the medium term, allowing the implementation of affordable advanced surface movement guidance and control systems	943 960

SAFELAND	Safe landing through enhanced ground support	SAFELAND aims to support the flight and landing of aircraft operated by a single pilot, in case of partial or total incapacitation of the pilot. SAFELAND will focus on the ground side, and specifically on the role ATM could have in managing the transition from a single-pilot-operated flight to a status with reduced or absent contribution of the on-board pilot to landing	1 978 138
SafeOps	From prediction to decision support – Strengthening safe and scalable ATM services through automated risk analytics based on operational data from aviation stakeholders	Maintaining the safety and cost-efficiency of air transport operations while increasing the capacity will push the next generation of ATM systems towards digitalisation. In the mid-term, a digitalised system in the human-operated ATM environment will be capable of delivering reliable predictive analytics based on automated information processing. SafeOps aims to support these future services by investigating the use of big data analytics together with new risk assessment methodologies	997 750
SIMBAD	Combining simulation models and big data analytics for ATM performance analysis	SIMBAD aims to develop and evaluate a set of ML approaches aimed at providing state-of-the-art ATM microsimulation models with the level of reliability, tractability and interpretability required to support performance evaluation at the European Civil Aviation Conference (ECAC) level effectively. The project will demonstrate and evaluate the newly developed methods and tools through a set of case studies	999 938
SINAPSE	Software-defined networking architecture augmented with AI to improve aeronautical communications performance, security and efficiency	SINAPSE aims to propose an intelligent and secured aeronautical data link communications network architecture design, based on the software-defined networking architecture model augmented with AI to predict and prevent safety service outages, to optimise available network resources and to implement cybersecurity functions protecting the network against digital attacks	853 300
SINOPTICA	Satellite-borne and in situ observations to predict the initiation of convection for ATM	SINOPTICA aims to explore the potential of assimilating remote-sensing, global navigation satellite system (GNSS)-derived datasets and in situ weather-station data into very high-resolution, very short-range numerical weather forecasts to provide improved predictions of extreme weather events to the benefit of ATM operations	999 285
SlotMachine	A privacy-preserving marketplace for slot management	Until now, air traffic flow management (ATFM) slots have been subject only to intra-airline swaps, used by airlines to prioritise expensive flights and thus minimise overall costs. Airlines want to keep the cost structure	1 937 739

		of their flights confidential, as they fear a competitive disadvantage when disclosed. This desire for confidentiality has hampered slot swapping between different airlines. SlotMachine aims to employ blockchain technology and secure multi-party computation to extend the existing UDPP with the possibility of keeping private the participating airlines' confidential information, such as the cost structure of flights	
START	A stable and resilient ATM by integrating robust airline operations into the network	START aims to develop, implement and validate optimisation algorithms for robust airline operations that result in stable and resilient ATM performance even in disturbed scenarios. The main focus of the project is the optimisation of conventional traffic situations while considering disruptive weather events such as thunderstorms	1 999 411
SYN+AIR	Synergies between transport modes and air transportation	SYN+AIR aims to generate common goals for transport service providers that will justify data-sharing while helping the user to execute a seamless door-to-door journey. SYN+AIR will generate customer door-to door journeys and will analyse how those journeys can be facilitated through improved planning and operations activities (following the ATFM phases: strategic, pre-tactical, tactical) powered by data-sharing	997 250
TAPAS	Towards an automated and explainable ATM system	TAPAS aims to explore highly automated AI-based scenarios through analysis and experimental activities applying explainable AI and visual analytics to derive general principles of transparency that pave the way for the application of AI technologies in ATM environments, enabling higher levels of automation	997 410
TRANSIT	Travel information management for seamless intermodal transport	TRANSIT aims to develop a set of multimodal key performance indicators (KPIs), mobility data analysis methods and transport simulation tools, allowing the evaluation of the impact of innovative intermodal transport solutions on the quality, efficiency and resilience of the door-to-door passenger journey	999 950
URClearED	A unified integrated remain-well-clear concept in airspace Classes D–G	URClearED aims to support current study activities on the remain-well-clear functionalities by defining and analysing operational scenarios, which allow the requirements of and assumptions made in current standards and applicable documents to be assessed. It aims to pave the way for future industrial-level activities on such systems	1 631 768

USEPE	U-space separation in Europe	USEPE aims to research drones' separation methods in highly demanding environments such as cities, and the use of ML algorithms to automate the safe separation and deconfliction of drones, while maintaining airspace capacity in different environments. The research approach will take into account both the strategic and the tactical flight phases	1 999 309
X-TEAM D2D	Extended ATM for door-to-door travel	X-TEAM D2D aims to define, develop and initially validate a concept of operations for the seamless integration of ATM and air transport into an overall intermodal network, including other available transportation means (ground and water), to enable door-to-door connectivity, within 4 hours, between any locations in Europe	997 375

Table 4: Ongoing ER4 projects in 2022 (under call for proposals H2020-SESAR-2019-2)

The abovementioned three areas of exploratory research are further complemented by the SESAR digital academy initiative.

The SESAR Digital Academy initiative aims to improve the skills of and inspire the next generation of the aviation workforce in anticipation of the digital economy.

The vision of the SESAR Digital Academy is to become a recognised 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; to promote student mobility and a whole spectrum of learning opportunities, from fundamental research to industry-focused applied research; and to enhance the knowledge, skills and employability of aviation professionals.

The SESAR Digital Academy seeks to bring together under one umbrella 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.

Linked with the knowledge transfer network (addressed by the ER3 project 'Engage'), and making use of a dedicated portal on the SESAR 3 JU's website, during 2021–2023 the initiative will increase the accessibility and visibility of existing SESAR outreach and will continue to highlight relevant events, such as the SESAR Innovation Days, along with other activities targeting students and the academic community, such as the Young Scientist Award.

2.2.2.2 *Digital European Sky programme*

The main activities will cover the finalisation of the call material and the publication of the S3 ER1 call (HORIZON-SESAR-2022-DES-ER-01). Following the call deadline, the proposals received will be evaluated according to the award criteria. The selected proposals will initiate their grant preparation phase, which will be concluded by the signing of the grants and the initiation of the execution of the projects.

Similarly, the call material of the S3 ER2 call (HORIZON-SESAR-2023-DES-ER-02) will be finalised with an initial publication date scheduled for the end of June 2023 leading to a call deadline for Mid-November 2023 and the start of the evaluation procedure.

2.2.2.3 ***Objectives, activities, indicators and targets***

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Build on the commitment of the wide scientific community around the SESAR topics	Organisation of the SESAR Innovation Days	Number of papers submitted (yearly)	Greater than 25	Greater than 30
		Active coordination with the scientific community (ASDA, Association of Scientific Development of ATM in Europe, Agency Research Team, ART)	Number of meetings organised (yearly)	At least 1 meeting with each organisation	At least 1 meeting with each organisation
		Develop a role for the European Aeronautics Science Network in and around the existing research community	Number of meetings and events organised with the European Aeronautics Science Network	At least 1 meeting and 1 event	At least 1 meeting and 1 event
		Organisation of the Young Scientist Award	Number of applications received	Greater than 10	Greater than 12
		Secure the active support of the SESAR 3 JU Scientific Committee	Number of active participations	1 Role in the SESAR Innovation Days	3
	Maintain the SESAR Digital Academy initiative and expand its outreach	Increase the content available through the SESAR Digital Academy	Number of visits to the SESAR Digital Academy website	140	150
		Expand the contributions across different sectors (academia, industry, standards and regulation)	Number of additional organisations contributing to the academy (yearly)	At least 4	At least 4
		Organisation of events under the framework of the SESAR Digital Academy	Number of events organised (yearly)	At least 2	At least 2

SESAR 2020	Supervise and close ER4 projects (under call for proposals H2020-SESAR-2019-2)	Execution of the Horizon 2020 reporting and payment process including the project reviews	Percentage of ER4 projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
Digital European Sky	Launch of call HORIZON-SESAR-2022-DES-ER-01 (S3 ER1) and evaluation of the proposals	Run the call for proposals and evaluation procedure	Evaluation report prepared in view of its submission to the ED	n/a	100 %
		Run the grant preparation phase	Grant agreement preparation and signing completed	n/a	100 %
	Supervise exploratory research projects (under call for proposals HORIZON-SESAR-2022-DES-ER-01)	Ramp up the projects	Percentage of S3 ER1 projects that have their project management plans approved	n/a	100 %
	Preparation and launch of call HORIZON-SESAR-2023-DES-ER-02 (S3 ER2)	Preparatory activities in view of the launch of the call	Call material ready for publication	n/a	100 %
		Run the call for proposals and start the evaluation procedure	Evaluation initiated	n/a	20 %

Table 5: Objectives, activities, indicators and targets for ER in 2022 and 2023

2.2.3 Strategic area of operation 3: Deliver industrial research and validation

2.2.3.1 *SESAR 2020 programme*

During the reporting period, SESAR 2020 industrial research and validation activities will facilitate the migration of ideas from exploratory research and will extend them further into applied research and towards the pre-industrial development stage, validation, large-scale demonstration and final preparation for deployment. Therefore, the main objective of this strategic area of operation is to deliver SESAR solutions that are derived from the European ATM Master Plan and identified in the SESAR 2020 MAWP.

This will be done through projects funded under the two calls for proposals restricted to the 19 SESAR JU members other than the EU and EUROCONTROL (i.e. wave 2 and wave 3 calls).

Facing the COVID-19 crisis, the projects reported to the SESAR JU Programme Committee greater than anticipated difficulty in implementing mitigation actions (e.g. the allocation of tasks to another contributor); in the case of airports, a refocus on core business, with a knock-on impact on R&I activities; and difficulty in accessing validation platforms and preparing validating exercises. Therefore, delays and their impact on programme output increased, for the following reasons: simulation facilities were not available or were not sufficient to cope with all of the demands (i.e. delayed exercises create a peak of demands) and, for some projects, 'buffers' to finalise the different outcomes and deliverables with the desired quality were consumed. As a result, the Programme Committee supported the JU's proposal to extend the duration of some grants as a key mitigation action to secure the delivery of the SESAR Solutions. This exercise was successfully conducted, leading to the signing at the end of 2021 of the grant amendments for extending the duration of 13 wave 2 and wave 3 projects until end of June 2023. The duration extension will allow the projects to reschedule their activities, providing more time to execute the validation activities, finalise the technical deliverables and run the maturity gates.

2.2.3.1.1 *IR wave 2 projects (from 2019 to mid-2023) – H2020-SESAR-2019-1*

The IR wave 2 call aims to enable the flexibility needed to align future research with the results of wave 1, reassess relative priorities and ensure the best value for money for the EU and delivery against the single European sky goals. This call will also allow for the completion of those candidate SESAR solutions that were not planned to be delivered to maturity level V3 within wave 1. Finally, it will allow strategic input for assessing new projects from the Master Plan update and to build on the results of the outcome of exploratory research projects from the ER1 call to increase the maturity of the research towards future solutions.

Furthermore, the results from the 12 IR wave 2 projects will provide the basis for setting up a changed ecosystem for aviation, and more specifically to modernise the underlying ATM infrastructure. This ecosystem will mainly be built upon ATM solutions characterised by:

- higher levels of autonomy and connectivity of all air vehicles, coupled with more automated traffic management;
- digital and automated tools provided on board the air vehicle itself or as part of the ground-based infrastructure;
- virtual technologies to decouple the physical infrastructure, such as sensors, communication devices and navigation devices, from the services that are provided to manage the airspace;
- big data analytics and open-source data usage to encourage the creation of new services;
- system modularity to allow scalable and easier upgrades and greater interoperability.

All solutions referred to in the following tables are being developed through IR wave 2 projects launched in Q4 2019.

High-performing airport operations

The high-performing airport operations industrial research projects will deliver the results (candidate SESAR solutions) in 2022.

Candidate SESAR solution reference	Candidate SESAR solution title	Expected maturity level by mid-2023	ATM system upgrade phase	European ATM Master Plan KPAs to which the solution contributes
PJ02 W2-04 (wave 2)	Advanced geometric GNSS-based procedures in the TMA	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency (fuel and CO_2 reduction) Predictability Safety Cost-efficiency Flexibility
PJ02 W2-14 (wave 2)	Evolution of separation minima for increased runway throughput	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency (fuel and CO_2 reduction) Resilience Safety Human performance
PJ02 W2-21 (wave 2)	Digital evolution of integrated surface management	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Predictability Safety Human performance
PJ02 W2-17 (wave 2)	Improved access to secondary airports	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Predictability Safety
PJ02 W2-25 (wave 2)	Safety support tools for avoiding runway excursions	V3	Phase B – efficient services and infrastructure delivery	Safety Human performance Interoperability Cost-efficiency Capacity
PJ04 W2-28 (wave 2)	Enhanced collaborative airport performance planning and monitoring	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Predictability Punctuality Operational efficiency (fuel and CO_2 reduction) Resilience
PJ04 W2-29 (wave 2)	Digital collaborative airport performance management	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Predictability Punctuality Operational efficiency (fuel & CO_2 reduction)

PJ05 W2-35 (wave 2)	Multiple remote towers and remote tower centre	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Access and equity Human performance
PJ05 W2-97 (wave 2)	Human–machine interface (HMI) interaction modes for airport tower	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Cost-efficiency Safety

Optimised ATM network services

The optimised ATM network services industrial research projects will deliver the results (candidate SESAR solutions) in 2022.

Candidate SESAR solution reference	Candidate SESAR solution title	Expected maturity level by mid-2023	ATM system upgrade phase	European ATM Master Plan KPAs to which the solution contributes
PJ07 W2-38 (wave 2)	Enhanced integration of civil airspace user trajectory definition and network management processes	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Operational efficiency (fuel and CO_2 reduction) Predictability Flexibility Access and equity
PJ07 W2-40 (wave 2)	Mission trajectories management with integrated dynamic mobile areas Type 1 and Type 2	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Safety Operational efficiency (fuel and CO_2 reduction) Capacity Predictability Human performance Cost-efficiency Flexibility Civil/military cooperation and coordination Access and equity
PJ07 W2-39 (wave 2)	Collaborative framework managing delay constraints on arrivals	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Predictability Flexibility Access and equity

Co-funded by the European Union

PJ09 W2-44 (wave 2)	Dynamic airspace configurations	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Safety Operational efficiency (fuel and CO_2 reduction) Capacity Predictability Human performance Cost-efficiency Flexibility Civil/military cooperation and coordination Access and equity
PJ09 W2-45 (wave 2)	Enhanced network traffic prediction and shared complexity representation	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Safety Operational efficiency (fuel and CO_2 reduction) Capacity Cost-efficiency Predictability Flexibility Access and equity
PJ09 W2-49 (wave 2)	Collaborative network performance management	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Safety Operational efficiency (fuel and CO_2 reduction) Predictability Cost-efficiency Capacity Flexibility Security Access and equity

Advanced air traffic services

The advanced ATSs industrial research projects will deliver the results (candidate SESAR solutions) in 2022.

Candidate SESAR solution reference	Candidate SESAR solution title	Expected maturity level by mid-2023	ATM system upgrade phase	*European ATM Master Plan* KPAs to which the solution contributes

Co-funded by the European Union

PJ01 W2-08 (wave 2)	Dynamic extended TMA for advanced continuous climb and descent operations and improved arrival and departure operations	V3	Phase B – efficient services and infrastructure delivery	Capacity Predictability Safety Cost-efficiency Operational efficiency (fuel and CO_2 reduction) Flexibility
PJ01 W2-06 (wave 2)	Advanced rotorcraft operations in the TMA	V2	Phase B – efficient services and infrastructure delivery	Capacity Predictability Safety Operational efficiency
PJ10 W2-73 (wave 2)	Flight-centric ATC and improved distribution of separation responsibility in ATC	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Flexibility Cost-efficiency Human performance Operational efficiency Predictability
PJ10 W2-93 (wave 2)	Delegation of airspace among ATSUs	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency Safety Human performance Cost-efficiency
PJ10 W2-96 (wave 2)	HMI interaction modes for ATC centre	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Safety Human performance Cost-efficiency
PJ13 W2-111 (wave 2)	Collision avoidance for IFR RPASs	V3	Phase B – efficient services and infrastructure delivery	Safety Interoperability
PJ13 W2-115 (wave 2)	IFR RPAS accommodation in airspace Classes A to C	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Safety Interoperability
PJ13 W2-117 (wave 2)	IFR RPAS integration in airspace Classes A to C	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Safety Interoperability

PJ18 W2-53 (wave 2)	Improved ground trajectory predictions enabling future automation tools	V3	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency Predictability Safety Human performance Cost-efficiency
PJ18 W2-56 (wave 2)	Improved vertical profiles through enhanced vertical clearances	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency Predictability Safety Human performance
PJ18 W2-57 (wave 2)	Reference business trajectory revision supported by data link and increased automation	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Capacity Operational efficiency Predictability Safety Human performance
PJ18 W2-88 (wave 2)	Trajectory prediction service	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Interoperability

Enabling aviation infrastructure

The enabling aviation infrastructure industrial research projects will deliver the results in 2021 and 2022. These projects are not mapped against the European ATM Master Plan KPAs, as their role in the work programme is to support the achievement of performance targets through operational projects. Similarly, the maturity of the candidate solutions in these projects is indicated according to the TRL criteria and not according to the European operational concept validation methodology like other key features.

Candidate SESAR solution reference	Candidate SESAR solution title	Expected maturity level by mid 2023	ATM system upgrade phase
PJ14 W2-76 (wave 2)	Integrated CNS and spectrum	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-77 (wave 2)	Future communication infrastructure services	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-60 (wave 2)	Future communication infrastructure terrestrial data link and alternative position, navigation and timing enabler (L-band	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations

	Digital Aeronautical Communications System (LDACS))		
PJ14 W2-107 (wave 2)	Future satellite communications data link	TRL6; ongoing	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-61 (wave 2)	Hyper-connected ATM	TRL2	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-81 (wave 2)	Long-term alternative position, navigation and timing	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-79 (wave 2)	Dual-frequency multi-constellation (DFMC) GNSS / satellite- and ground-based augmentation systems (SBAS and GBAS)	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-110 (wave 2)	Aircraft as an aeronautical information management / meteorological sensor and consumer	TRL4	Phase B – efficient services and infrastructure delivery
PJ14 W2-83 (wave 2)	Surveillance performance monitoring	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ14 W2-84 (wave 2)	New use and evolution of cooperative and non-cooperative surveillance	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ17 W2-100 (wave 2)	System-wide information management (SWIM) technical infrastructure purple profile for air/ground safety-critical information-sharing	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations
PJ17 W2-101 (wave 2)	SWIM technical infrastructure green profile for ground/ground civil–military information-sharing	TRL6	Phase C – regional, trajectory-based, flight- and flow-centric operations

Table 6: Delivery of candidate SESAR solutions in 2022 (under the call for proposals with reference H2020-SESAR-2019-1)

2.2.3.1.2 IR wave 3 projects (from 2020 to mid 2023) – H2020-SESAR-2020-2

The objective of the wave 3 call for proposals is to optimise coverage of the R&I topics identified in the SESAR 2020 programme as necessary to address phase C of the European ATM Master Plan taking due account of the outcome of the airspace architecture study.

The three IR wave 3 projects are developing their solutions with a particular focus on virtual centre operations, the increased flexibility in the allocation of ATCOs from a specific system rather than a specific geographical area perspective, and the further development of the collaborative ATM and U-space environment for the simultaneous operation of drones and manned aviation. The projects co-financed under this call are expected to deliver the results (candidate SESAR solutions) set out in Table 9 in 2022.

Candidate SESAR solution reference	Candidate SESAR solution title	Expected maturity level by mid 2023	ATM system upgrade phase	European ATM Master Plan KPAs to which the solution contributes
PJ32 W3-01	ATFCM aspects of airspace delegation across ATSUs	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Human performance Capacity
PJ33 W3-01a	Increased flexibility in ATCO validation supported by advanced controller assistance systems and procedures	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Human performance Capacity
PJ33 W3-01b	Generic controller validations	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Human performance Capacity
PJ33 W3-02	LDACS digital voice capability	TRL4	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency
PJ34 W3-01	Collaborative U-space ATM interface	V2	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Human performance Safety
PJ34 W3-02	Highly-automated collaborative U-space ATM interface	V1	Phase C – regional, trajectory-based, flight- and flow-centric operations	Cost-efficiency Human performance Safety

Table 7: Delivery of candidate SESAR solutions by mid-2023 (under the call for proposals with reference H2020-SESAR-2020-2)

2.2.3.2 *Digital European Sky programme*

The main activities will cover the finalisation of the call material related to industrial research and fast-track innovation and uptake topics and the publication of the S3 IR1 call (HORIZON-SESAR-2022-DES-IR-01). Following the call deadline, the proposals received will be evaluated according to the award criteria. The selected proposals will initiate their grant preparation phase, which will be concluded by the signing of the grants and the initiation of the execution of the projects.

In addition, technical contribution to the definition of the EU-Rail – SESAR Synergy call for proposals (HORIZON-ER-JU-2023-FA1-SESAR) under the Horizon Europe programme with the EU-Rail JU will be provided, allowing the publication of the call at the end of Q3 2023.

2.2.3.3 ***Objectives, activities, indicators and targets***

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 2020	Execute validation exercises of release 11	Execute validation exercises of release 11	Percentage of release 11 solution validation exercises completed	100 %	n/a
	Close release 11	Close release 11	Delivery of the release 11 close-out report	Report available and approved by the Programme Committee	n/a
	Execute validation exercises of release 12	Execute validation exercises of release 12	Percentage of release 12 (candidate) solution validation exercises completed	90 %	10 %
	Supervise and close IR-VLD wave 2 projects (under call for proposals H2020-SESAR-2019-1)	Execution of the Horizon 2020 reporting and payment process	Percentage of wave 2 project reviews completed	100 %	n/a
		Delivery of project results and closure of grants	Percentage of wave 2 projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
	Supervise and close IR-VLD wave 3 projects (under call for proposals H2020-SESAR-2020-2)	Execution of the Horizon 2020 reporting and payment process	Percentage of wave 3 project reviews completed	100 %	n/a

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
		Delivery of project results and closure of grants	Percentage of wave 3 projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
Digital European sky programme	Launch of call HORIZON-SESAR-2022-DES-IR-01 (S3 IR1) and evaluation of the proposals	Run the call for proposals and evaluation procedure	Evaluation report prepared in view of its submission to the ED	n/a	100 %
		Run the grant preparation phase	Grant agreement preparation and signing completed	n/a	100 %
	Supervise industrial research projects (under call for proposals HORIZON-SESAR-2022-DES-IR-01)	Ramp up the projects	Percentage of IR1 projects that have their project management plans approved	n/a	100 %
	Technical contribution to the EU-RAIL – SESAR Synergy call for proposals (HORIZON-ER-JU-2023-FA1-SESAR) under the Horizon Europe programme with the Europe's Rail Joint Undertaking	Definition of the technical specifications	EU-RAIL – SESAR Synergy call open	n/a	100%

Table 8: Objectives, activities, indicators and targets for IR in 2022 and 2023

2.2.4 Strategic area of operation 4: Facilitate an accelerated market uptake of SESAR Solutions

SESAR solutions must achieve a high degree of maturity at the end of the development and validation processes and must prove to be ready for deployment, in particular in the framework of the common projects. This ability is tested via large-scale demonstrators (VLD in the S2020 programme and DSDs in the DES programme), taking place in live operational environments. In this context, the SESAR 3 JU is working in close collaboration and synergy with the SESAR Deployment Manager and the EASA.

2.2.4.1 *SESAR 2020 programme*

VLDs are designed to help bridge the gap between the development and deployment phases of the SESAR programme; they are not designed to replace either type of activity. VLDs use early versions of end-user systems and include the integration of new technology elements into existing systems when needed and when possible. As such, VLDs will mostly derive from work matured through an earlier phase of industrial research.

From 2022 to 2023, the SESAR 3 JU will, in the context of VLDs, supervise and ensure the final delivery of the wave 2, wave 3 and VLD Open 2 projects, then close the grant agreements by mid 2023. The SESAR 3 JU will then ensure the financial and administrative closure of the grant agreements by the end of 2023.

2.2.4.1.1 VLD wave 2 projects (from 2019 to mid 2023) – H2020-SESAR-2019-1

The three VLD projects demonstrate the following ATM solutions:

- runway enhanced approaches (e.g. increased glide slope and second runway aiming point) supported by advanced GNSS navigation technologies with business jets and commercial aircraft;
- traffic alerts for pilots during runway operations to prevent runway incursion and aircraft collision addressing both mainline and business aviation;
- fundamental changes in wake turbulence separation minima, safe and efficient runway use tailored to the individual aircraft level using new technology and analytics, and reduced radar separation minima on final approach.

A summary of the VLD wave 2 projects launched into execution by the end of October 2020 is provided in able.

Project reference	Project title	Short project description	Maximum grant amount (EUR)
VLD01 W2 DREAMS	Demonstration of runway enhanced approaches made with satellite navigation	The project intends to demonstrate how GNSS technology can bring benefits in terms of enhancing arrival procedures developed in wave 1. The demonstration will cover business jets and mainline aircraft and will pioneer flights on GBAS CAT-III operations	4 481 278

VLD02 W2 STAIRS	Airport surface management, airport safety nets and airborne traffic situation awareness	The project intends to demonstrate the use of specific avionics (validated within wave 1) that provide traffic alerts for pilots during runway operations to prevent runway incursion and aircraft collision. The demonstration will address both mainline and business aviation solutions during the life cycle of the demonstration project; the systems will go through a full certification review process to ensure compliance with the applicable certification specification and to be ready for deployment	3 948 760
VLD03 W2 SORT	Safely optimised runway throughput	The projects aims to demonstrate fundamental changes in wake turbulence separation minima, safe and efficient runway use tailored to the individual aircraft level using new technology and analytics, and reduced radar separation minima on final approach	4 500 000

Table 9: Ongoing Wave 2 VLD projects in 2022 (under the call for proposals with reference H2020-SESAR-2019-1)

2.2.4.1.2 *VLD wave 3 projects (from 2020 to mid 2023) – H2020-SESAR-2020-2*

The two VLD projects (Table 12) demonstrate the following ATM solutions:

- integrating time-based separation for final approach, arrival management (AMAN) extended to en-route airspace (E-AMAN) and required navigation performance (RNP)-based operations in the terminal airspace (RNP 1) with pairwise wake separation minima and flight-deck interval management;
- operational use of automatic dependent surveillance contract (ADS-C) data demonstrating both the improvements that can be achieved in many common operational situations that ATCOs have to manage and the efficiency and robustness of technological infrastructure to support the exchange of trajectory-related information between the aircraft and various ground consumers using data link communications.

Project reference	Project title	Short project description	Maximum grant amount (EUR)
PJ37 ITARO	Integrated TMA, airport and runway operations	The project intends to demonstrate integrating time-based separation for final approach, AMAN extended to en-route airspace (E-AMAN) and RNP-based operations in the terminal airspace (RNP 1) with pairwise wake separation minima and flight-deck interval management	4 292 802

PJ38 ADSCENSIO	ADS-C enables and supports improved ATM operations	The project intends to expand the operational use of ADS-C data demonstrating both the improvements that can be achieved in many common operational situations that ATCOs have to manage and the efficiency and robustness of technological infrastructure to support the exchange of trajectory-related information between the aircraft and various ground consumers using data link communications	6 759 969

Table 10: Ongoing wave 3 VLD projects in 2022 under the Wave 3 call for proposals

2.2.4.1.3 *Open 2 projects (from 2020 to mid 2023) – H2020-SESAR-2020-1*

The eight demonstration activities will mainly address:

- the safe integration of drones with the demonstration of U-space capabilities and services to enable UAM using different unmanned platforms, such as passenger electric VTOL vehicles and hydrogen fuel cell VTOL vehicles, combined with manned aviation in an authentic urban environment;
- the demonstration of ATM operations mitigating aviation's environmental footprint and contributing to the reduction of CO_2 emissions, with the target being flights with zero waste of fuel and CO_2 emissions (i.e. fuel consumption as close as possible to the theoretical optimum);
- the demonstration of the use of satellite-based VHF systems providing voice and data link communications to allow ATS traffic in remote airspace to be handled in the same way as in a continental environment, and that current separation can be reduced without compromising safety.

A summary of each project can be found in table.

Project reference	Project title	Short project description	Maximum grant amount (EUR)
ALBATROSS	ALBATROSS: The most energy efficient flying bird	The project will demonstrate a 'perfect zero fuel and CO_2 emissions waste flight' in real conditions, through a series of live trials in various European operating environments and adopting the following approach: calculate the optimum flight profile, check ATM constrains and try to relax them, then finalise the optimum flight	3 996 331

AMU-LED	Air mobility urban – Large experimental demonstrations	The project proposes to design and deliver a detailed concept of operations and a definition of urban air missions followed by a large real-flight demonstration campaign to (1) address various use cases applicable to logistics and the urban transport of passengers, (2) design or integrate a UAM environment, (3) test the UAS ground and airborne platforms and (4) assess safety, security, sustainability and public acceptance	3 997 415
CORUS-XUAM	Concept of operations for European U-space services – Extension for UAM	The project will update the U-space concept of operations, addressing the integration of UAM/UAS operations into the airspace, also identifying new U3/U4 services. The project will then combine flights by electric VTOL vehicles with other traffic and operations in the controlled traffic regions of major airports with a focus on different types of missions, such as passenger transport, logistic, delivery, emergency response and surveillance missions, using different U-space deployment architectures and state-of-the-art technologies	3 999 389
GOF2.0	GOF2.0 integrated urban airspace VLD	The project will demonstrate the operational validity of serving combined UAS, electric VTOL and manned operations in a unified, dense urban airspace using current ATM and U-space services and systems. The demonstrations focus on the validation of the GOF 2.0 architecture for highly automated real-time separation assurance in dense airspace including precision weather and telecommunications networks for air–ground communication	3 911 774
SAFIR-Med	Safe and flexible integration of advanced U-space services focusing on medical air mobility	The project will demonstrate the integration of medical air mobility unmanned aerial vehicle (UAV) platforms and services within a real urban environment. Technologies of all partners will be leveraged to make use of the maximum number of U-space services, working towards the highest possible operational safety	2 038 609

		level, including advanced detect-and-avoid U-space services	
TINDAiR	Tactical instrumental deconfliction and in-flight resolution	The project will demonstrate the safe integration of UAM as an additional airspace user. The results of the VLD will help to refine the safety, performance, standardisation and regulatory requirements to enable UAM. The VLD will include the execution of flight demonstrations in accordance with the safety conditions	3 269 884
Uspace4UAM	U-space for UAM	The project will bridge the gap between development and deployment for U-space capabilities and services that will enable a safe introduction of UAM in Europe. It will study safety cases and their impact on system requirements, and it will look at how regulation and standardisation can be set up to support innovators to build a sustainable business case while operating safely in a multimodal transport network	3 999 966
VLD2-VOICE	Reduced separations and improved efficiency based on VHF communications over low Earth orbit satellites	The project will demonstrate that with the use of satellite-based VHF systems providing voice and data link ATS, traffic in remote airspace can be handled in the same way as in a continental environment, and current separation can be reduced without compromising safety. The demonstration will cover operations in Canarias and Sal flight information regions, where ATCOs communicate in real time with aircraft at distances greater than 1 500 km	3 989 808

Table 11: Ongoing VLD Open 2 projects in 2022 (under the call for proposals with reference H2020-SESAR-2020-1)

2.2.4.2 *Digital European Sky programme*

The main activities will consist in providing technical support to CINEA for the call for proposals CEF-T-2021-SIMOBGEN. CINEA will remain responsible for the contractual management of the grants, while the SESAR 3 JU will provide technical expertise, in particular during the evaluation of the proposals and the grant preparation phase. As soon as the grants are signed by CINEA, the SESAR 3 JU will closely monitor the projects launched to ensure their alignment with the SESAR 3 JU expectations. This technical monitoring will be closely coordinated with CINEA.

Similarly, a second call for proposals for DSDs (CEF-T-2022 SIMOBGEN) will be launched in September 2022, funded under the CEF programme. CINEA will remain responsible for the contractual management of the grants, while the SESAR 3 JU will provide technical expertise. The deadline for the submission of the proposals is planned for 18 January 2023 leading to an evaluation and grant preparation phases of the selected proposals during the summer and the signature of the grants in September 2023.

A third call for proposals for DSDs (CEF-T-2023 SIMOBGEN) is also planned to be launched in September 2023, funded under CEF programme. The main activities of the SESAR 3 JU will consist in providing technical support to CINEA for the definition of the topic.

As for the S2020 programme, the SESAR 3 JU will also continue to cooperate closely with partner entities, and in particular with the SESAR Deployment Manager and the European Union Aviation Safety Agency. This is particularly important in view of facilitating the deployment of mature solutions and functionalities.

2.2.4.3 *Objectives, activities, indicators and targets*

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Facilitate an accelerated market uptake of SESAR solutions (for VLDs and Digital Sky Demonstrators)	Organising and coordinating large-scale demonstration activities Coordinating closely with the European Union Aviation Safety Agency (EASA) to enable timely development by EASA of regulatory measures that fall under the EASA basic regulation and the relevant implementing rules Supporting the related standardisation activities, in close cooperation with standardisation bodies and EASA, as well as with the entity established to coordinate the tasks of the SESAR deployment phase in line with Commission Implementing Regulation (EU) No 409/2013	Level of compliance of the JU with the regulatory requirements on facilitating market uptake	100 %	100 %

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 2020	Supervise and close IR-VLD wave 2 projects (under call for proposals H2020-SESAR-2019-1)	Execution of the Horizon 2020 reporting and payment process	Percentage of wave 2 project reviews completed	100 %	n/a
		Delivery of project results and closure of grants	Percentage of wave 2 projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
	Supervise and close IR-VLD wave 3 projects (under call for proposals H2020-SESAR-2020-2)	Execution of the Horizon 2020 reporting and payment process	Percentage of wave 3 projects review completed	100 %	n/a
		Delivery of project results and closure of grants	Percentage of wave 3 projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
	Supervise and close VLD Open 2 projects (under call for proposals H2020-SESAR-2020-1)	Execution of the Horizon 2020 reporting and payment process	Percentage of VLD Open 2 call project reviews completed	100 %	n/a
		Delivery of project results and closure of grants	Percentage of VLD Open 2 call projects that have submitted their final Horizon 2020 technical and financial report	n/a	100 %
Digital European sky	Provide technical expertise to CINEA for call for proposals CEF-T-2021-SIMOBGEN	Finalisation of the launch of the call and beginning of project implementation	Percentage of the targeted number of grant agreements signed for S3 DSD1 projects (main list)	100 %	n/a
			Percentage of the S3 DSD1 projects having their project	100 %	n/a

Objectives	Activities	Indicators	Target for 2022	Target for 2023
		management plan approved		
Provide technical expertise to CINEA for call for proposals S3 DSD1b	Finalisation of the launch of the call	Contribution to the technical specifications	100 %	n/a
	Call evaluation and beginning of project implementation	Contribution to the evaluation	n/a	100 %
Provide technical expertise to CINEA for DSD call CEF-T-2023-SIMOBGEN	Finalisation of the launch of the call	Contribution to the technical specifications	n/a	100%

Table 12: Objectives, indicators and targets for VLDs and DSDs in 2022 and 2023

2.2.5 Strategic area of operation 5: Deliver SESAR outreach (cooperation, synergies and cross-cutting themes and activities)

2.2.5.1 *Synergies*

2.2.5.1.1 Maximising synergies across Horizon Europe

In 2022 and 2023, the SESAR 3 JU will seek to put in place measures to maximise its impact using all possible synergies with other European partnerships and related national activities, consistent with the expectations laid down in the Single Basic Act.

As a first step, the SESAR 3 JU will reach out to other mobility joint undertakings to explore possibilities for building consolidated roadmaps and action plans for climate-neutral mobility solutions. The aim is to address common sectorial issues such as multimodal transport, automated vehicles and the decarbonisation of the sector. As a result, the SESAR 3 JU will aim to maximise its impact through the EU-RAIL – SESAR Synergy call call for proposals with the EU-Rail JU planned to be launched in Q3 2023 (for more details about the call see Annex II, section 2.4). Aviation and railway are integral parts of the intermodal transport ecosystem expected to optimise door-to-door mobility for people. In particular, the synergy between SESAR 3 JU and EU's Rail JU will allow contributing to the optimisation of fuel-burn and therefore reductions of CO_2 emissions per journey. Additional environmental benefits (i.e. emissions, noise and/or local air quality) will come from alleviating congestion at and around airports and/or railway stations by improving passenger flows.

SESAR 3 JU will also seek to establish coordination with the European partnership for clean aviation, namely the Clean Aviation Joint Undertaking, during the course of 2022. Opportunities will be sought for complementary or joint activities, notably joint demonstration activities, which would enable the two programmes to demonstrate in practice the complementarities and synergies between them. Such coordination could also allow the programmes to evaluate the combined benefits and impact of particular solutions, in particular the measurement of the aggregated effect of green operations and green aircraft on the achievement of the overall decarbonisation goal. To facilitate joint demonstration activities, there will need to be a sufficiently flexible funding framework in place.

An initial set of potential areas to demonstrate these synergy effects has been identified (this list is not exhaustive):

- combined simulations
- performance and impact assessment
- autonomous operations
- airport infrastructure for new vehicles.

As a second step, the SESAR 3 JU will explore opportunities for synergies with the European partnerships in the cluster 'digital, industry and space', given that the digital transformation of aviation is at the core of the SESAR 3 JU's goals. For example, AI, cybersecurity and high-performance computing are cross-sectorial issues that require significant coordination, especially for the development of use cases and the application of European standards. In addition, these partnerships will contribute to the achievement of the European space policy. According to the European ATM Master Plan, satellite communication, navigation and surveillance services are considered essential enablers of the Digital European Sky. Therefore, the partnership will build on the achievements of SESAR 2020 in the space domain to further engage the space actors in the innovation ecosystem.

2.2.5.1.2 Synergies with CINEA

The implementation of Digital Sky Demonstrators as part of the Digital European Sky programme requires strong cooperation with CINEA, as in Section 2.2.4.2 of this chapter.

2.2.5.1.3 Coherence and synergies in relation to major national (sectorial) policies, programmes and activities

The SESAR 3 JU will also seek to exploit all possible synergies in relation to major national (sectorial) policies, programmes and activities (such as those that will be part of the Recovery and Resilience Facility – an EU stimulus package – to ensure maximum levels of complementarity and impact). It will aim to leverage local investments and complement the R&I needs by looking at the wider European goals and applications.

During 2022 and 2023, the SESAR 3 JU will explore opportunities for coordination with national and regional initiatives, consulting widely through the newly established States' Representatives Group.

2.2.5.2 ***Stakeholder engagement***

The SESAR 3 JU's outreach work during 2022–2023 will target and involve a wide range of SESAR 3 JU member and stakeholder organisations. This outreach aims to secure the involvement of stakeholders in the SESAR 3 JU's R&I activities, including in support of validating SESAR solutions, as well as to ensure close coordination and, where appropriate, alignment with activities delivered by other organisations, but which are of strategic importance to the success of the SESAR project, such as standardisation.

2.2.5.2.1 Institutional stakeholders

The SESAR 3 JU will maintain close relations with its key institutional stakeholders, such as the European Parliament, the European Council and the European Commission, along with EUROCONTROL, to ensure that its activities are aligned with and take into account developments in the EU's policy on ATM. It will also establish appropriate cooperation and coordination with the following organisations, including through formal cooperative arrangements when appropriate.

EASA. The service-level agreement (SLA) between the SESAR 3 JU and EASA secures close collaboration between these organisations to ensure an early exchange of knowledge on new technologies being developed, thereby facilitating the certification and regulatory process of resulting products and services, and ultimately accelerating market uptake of SESAR solutions. The arrangements will allow EASA to contribute expertise in support of key SESAR project activities and, at the same time, allow the SESAR 3 JU to provide support to EASA in European and international activities that relate to securing the necessary safety, security and regulatory arrangements.

European Defence Agency (EDA). Through its memorandum of cooperation with the EDA, the SESAR 3 JU will secure support and buy-in from the military community (in their roles as ANSPs, airport operators, airspace users and regulators) in relation to SESAR 3 JU activities and the European ATM Master Plan. In particular, areas of common interest include the European ATM Master Plan, regulations, space-based systems, the integration of UAS, cybersecurity threats and vulnerabilities of ATM, and the development of aviation/ATM standards.

European Space Agency (ESA). Through its memorandum of cooperation with ESA, the SESAR 3 JU will secure strategic cooperation to coordinate roadmaps, specifically in relation to the integrated CNS strategy defined in the European ATM Master Plan, defining the role of satellite communications as an element of importance for the future enabling CNS infrastructure for ATM.

EU Agency for the Space Programme. The SESAR 3 JU will seek coordination in relation to the role of the European Geostationary Navigation Overlay Service (EGNOS) and Galileo in the future multifrequency, multi-constellation GNSS system.

2.2.5.2.2 Industry stakeholders

The SESAR 3 JU will foster strong ties with key European stakeholder groups, including, in particular, the following.

SESAR deployment. The SESAR 3 JU will establish formal cooperation with the entity established to coordinate the tasks of the SESAR deployment phase to ensure the necessary connections between SESAR research, development, innovation and validation activities and SESAR deployment.

Advisory Council for Aviation Research and Innovation in Europe (ACARE). The SESAR 3 JU will participate in the advisory council to ensure the appropriate representation of ATM in the European strategic R&I agenda, and to secure the link with *Flightpath 2050*.

Standardisation bodies. The contribution of the SESAR 3 JU to the development of European standards is of key importance in helping accelerate market uptake of SESAR solutions. During 2022–2023, the SESAR 3 JU will seek to intensify its engagement with relevant standards development organisations and in particular EUROCAE through strengthening the pre-existing memorandum of understanding reflecting the new regulatory obligations of the SESAR 3 JU. The SESAR 3 JU will continue to participate actively in the EUROCAE Council and the Technical Advisory Committee, as well as the European ATM Standards Coordination Group and the European UAS Standards Coordination Group. The aim is to secure close collaboration between the SESAR 3 JU members and the availability of SESAR material in support of standardisation, and to enable SESAR material to be used to plan the effective development of standards to support European regulation, international standardisation and the delivery of the European ATM Master Plan and the ICAO global air navigation plan (GANP).

ANS providers (ANSPs). The SESAR 3 JU will work closely with the Civil Air Navigation Services Organisation (CANSO) to ensure the broadest possible awareness of SESAR 3 JU activities and to secure engagement and buy-in from ANSPs, including those outside the membership of the SESAR 3 JU.

Professional staff organisations. The SESAR 3 JU will put in place arrangements to secure the support of different professional staff associations to provide operational and technical knowledge of direct relevance to the successful delivery of SESAR results and solutions. This will also serve to enhance the buy-in of front-end users in relation to ATM modernisation and SESAR solutions.

Civil and military airspace users. The SESAR 3 JU will continue to reach out to airspace user organisations to secure awareness of and commitment to its work and activities, including putting in place arrangements to secure, where appropriate, their technical expertise and advice for project-related activities.

European airports. The SESAR 3 JU will work closely with European airports and the Airports Council International (ACI) on airport-related activities in its work programme to secure airports' active engagement and to raise awareness of SESAR among airport partners, including through events such as roadshows and conferences.

New entrants. New innovative airspace users and organisations in the field of unmanned traffic management / U-space, UASs and HAO will be approached based on relevant EU strategies and on a case-by-case basis to find the most efficient mechanism of cooperation for the benefit of SESAR 3 JU tasks and activities.

Small and medium-sized enterprises (SMEs) and start-ups. The SESAR 3 JU will seek opportunities to reach out to SMEs and start-ups to associate them with its activities and thereby help stimulate and scale up the R&I network. This will include exploring the possibilities to put in place cooperative arrangements to inform and involve this community, for example with the European Aerospace Cluster Partnership sponsored by the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs and the European Start-Up Prize for Mobility under the patronage of the European Parliament.

2.2.5.3 *Cooperation with non-EU countries and international organisations*

Pursuant to its strategy for cooperation with third countries and international organisations, the SESAR 3 JU will continue during 2022–2023 to engage actively with key international partners in support of global interoperability and harmonisation. It will do so in close coordination with the European Commission to ensure consistency and alignment with the EU's broader aviation strategy, in particular its external affairs dimension.

At the global level, in relation to ICAO, the SESAR 3 JU will maintain active participation and collaboration under the leadership of the European Commission. This will include participation in the preparation of Europe's contributions to the 41st ICAO Assembly in 2022. The SESAR 3 JU will also participate in the ICAO GANP Study Group, which oversees the future evolution of the ICAO GANP. The alignment between the ICAO GANP, the ATM Master Plan and the SESAR 2020 programme is essential to de-risk development towards deployment.

The SESAR 3 JU will maintain and intensify its close collaboration with the US Federal Aviation Administration (FAA) and its next generation air transportation system (NextGen) programme under the umbrella of the EU–US memorandum of cooperation on ATM modernisation, civil aviation research and development, and global interoperability. The existing cooperative arrangements with other international partners covering the ATM domain, whether of the SESAR 3 JU or at the level of the European Commission or the EU, will be further enhanced during 2022–2023 as SESAR solutions evolve and are deployed. This includes arrangements with Georgia, Japan, Qatar and Singapore. The SESAR 3 JU will also work closely with the European Commission and other SESAR members to identify and leverage opportunities to extend and deepen international collaboration, including under EU technical cooperation projects with China, Latin America, South Asia and South-East Asia. In doing so, the SESAR 3 JU will closely follow the policies of the EU and the needs of the EU aviation strategy and of the single European sky framework.

2.2.5.4 ***Objectives, activities, indicators and targets***

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Ensure global ATM interoperability and harmonisation based on SESAR solutions	Active engagement with international partners through ICAO and bilaterally, including via cooperative arrangements with key partners	Coverage of ICAO GANP aviation system block upgrade modules	Securing inputs to and outcomes from the 41st ICAO Assembly in 2022 that are aligned with the SESAR 3 JU's priorities and requirements	Active participation in the ICAO GANP Study Group
			Transparent progress towards interoperability and harmonisation between SESAR and NextGen	Prioritised work plan agreed with the FAA under the EU–US memorandum of cooperation	Progress against agreed work plan
			Number of cooperative arrangements in place with international partners	Actors and initiatives to be addressed as priority: • United States • Singapore • Japan • Qatar	Actors and initiatives to be addressed as priority: • United States • Singapore • Japan • Qatar
Digital European Sky	Seek and maximise synergies with relevant activities and programmes at EU, national and regional levels	Active engagement with relevant European partnerships and national or regional programmes or initiatives	Number of cooperative arrangements or engagements with relevant partnerships, programmes or initiatives	Actors and initiatives to be addressed as a priority: • Clean Aviation Joint Undertaking • national (sectorial) policies, programmes and activities	Actors and initiatives to be addressed as a priority: • Clean Aviation Joint Undertaking • Europe's Rail Joint Undertaking • national (sectorial) policies, programmes and activities

<table>
<tr><th>Objectives</th><th>Activities</th><th>Indicators</th><th>Target for 2022</th><th>Target for 2023</th></tr>
<tr><td>Secure the active involvement of the civil and military stakeholders of the aviation sector in the Digital European Sky R&I programme</td><td>Active cooperative arrangements or agreements with European stakeholders</td><td>Number of cooperative arrangements or agreements in place</td><td>Actors and initiatives to be addressed as a priority:
• EASA
• EDA
• ESA
• EUROCAE
• airports (ACI Europe)
• professional staff organisations</td><td>Actors and initiatives to be addressed as a priority:
• EASA
• EDA
• ESA
• EUROCAE
• airports (ACI Europe)
• professional staff organisations</td></tr>
<tr><td rowspan="2">Strengthen links with standards-making organisations in the context of the enlarged scope of the SESAR 3 JU</td><td rowspan="2">Develop an approach to better integrate standards identification, planning and application during industrialisation, by defining the stakeholder relationship with EUROCONTROL, EASA and EUROCAE in the scope of the SESAR 3 JU Single Basic Act</td><td rowspan="2">Level of the collaboration between the SESAR 3 JU, EASA, EUROCONTROL and other standards-developing organisations, in particular EUROCAE (to be reflected in the various standards coordination groups and market uptake)</td><td>Joint position paper with EASA and EUROCONTROL established, respecting the regulatory and statutory responsibilities of each organisation and the objective to better support industrialisation and market uptake</td><td rowspan="2">Agreed position described in the position paper with EASA and EUROCONTROL enacted through SESAR 3 JU contributions to EUROCAE and the standards coordination groups, while maintaining the tripartite collaboration</td></tr>
<tr><td>Memorandum of understanding with EUROCAE renewed and updated to reflect the agreed needs of the SESAR 3 JU, EASA and EUROCONTROL</td></tr>
</table>

Table 13: Objectives, activities, indicators and targets for delivering SESAR outreach in 2022 and 2023

2.3 Calls for proposals

As defined in Article 5.2(a) of the Single Basic Act, the SESAR 3 JU will provide financial support, mainly in the form of grants, to R&I indirect actions, selected following open, transparent and competitive calls ensuring their openness for any newcomers.

Figure 5 provides an overview of the high-level planning and calls sequence of the Digital European Sky programme for 2021–2030.

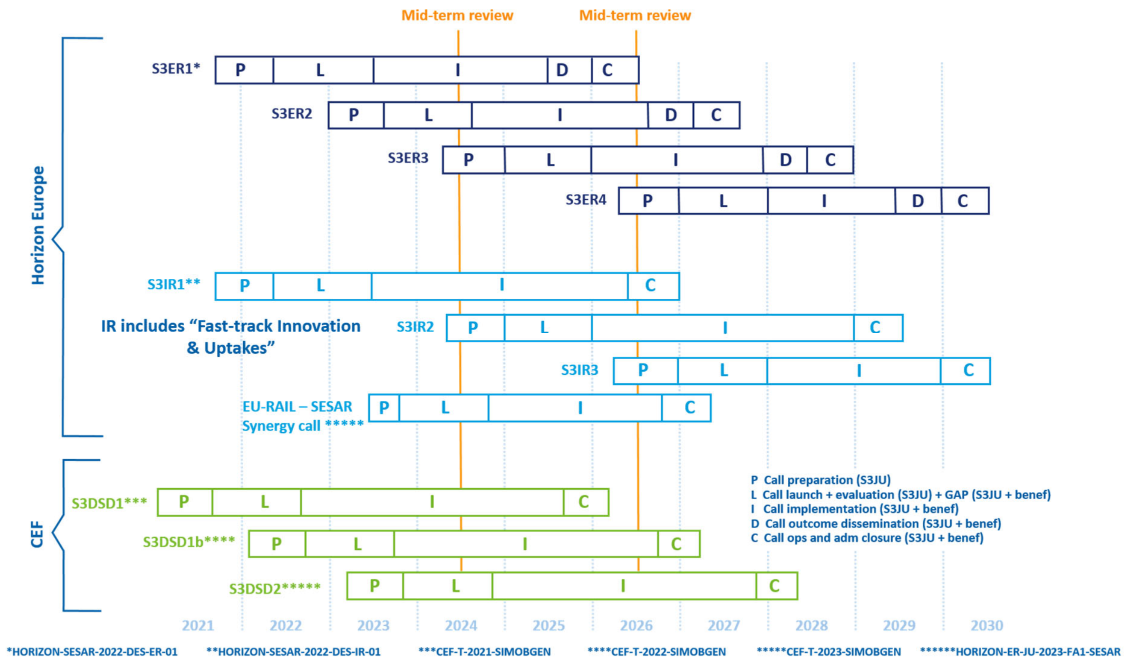


Figure 5: **The Digital European Sky calls sequence**

The following activities are scheduled to take place in 2022 and 2023 in relation to the calls for proposals:

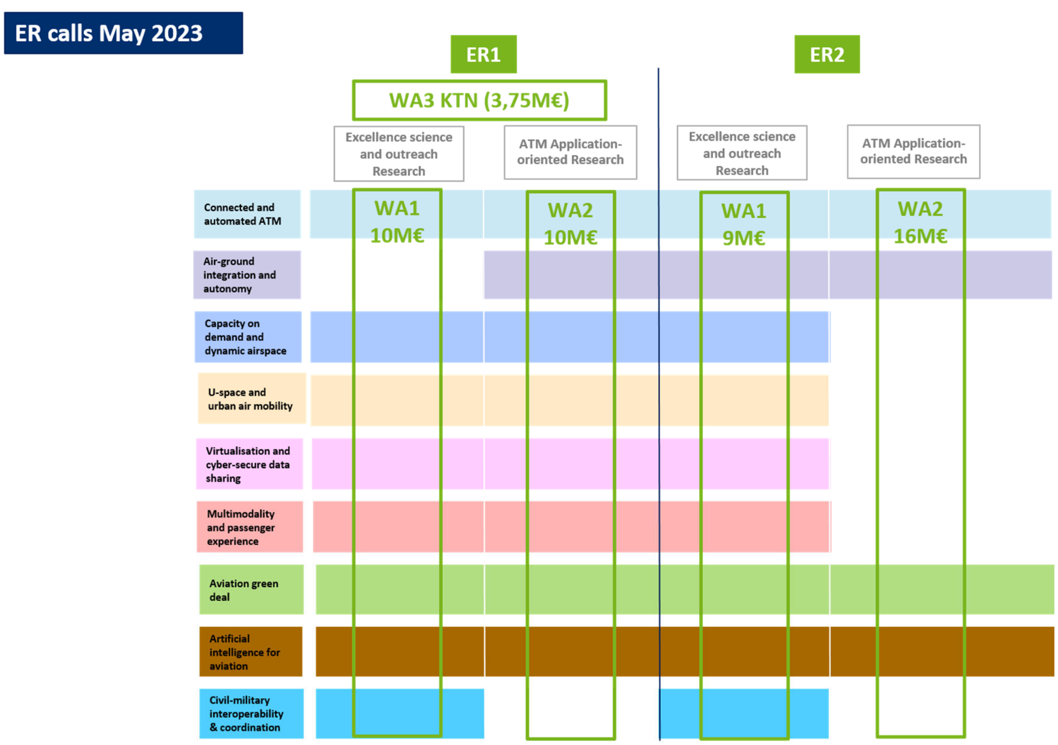
- the management of grant agreements through monitoring project implementation and the execution of payments in accordance with the financial circuit for the grant agreements within the Horizon 2020 set of rules on when reporting periods become due and/or projects close their work and final payment is due, namely:
    - the IR and VLD wave 2 grants resulting from restricted call for proposals H2020-SESAR-2019-1;
    - the IR and VLD wave 3 grants resulting from restricted call for proposals H2020-SESAR-2020-2;
    - the VLD Open 2 grants resulting from open call for proposals H2020-SESAR-2020-1;
    - the ER4 grants resulting from open call for proposals H2020-SESAR-2019-2;
- the management of four new calls for proposals within the Horizon Europe set of rules, the conditions of which are defined in Annex II, namely:
    - the open Digital European Sky ER1 call for proposals (HORIZON-SESAR-2022-DES-ER-01), including the launch, evaluation, award, grant agreement preparation and signing, as

well as the launch of projects and the related management of grant agreements;

- the open Digital European Sky IR1 call for proposals (HORIZON-SESAR-2022-DES-IR-01),, including the launch, evaluation, award, grant agreement preparation and signing, as well as the launch of projects and the related management of grant agreements;
- the open digital European sky ER2 call for proposals (HORIZON-SESAR-2023-DES-ER-02), including preparation and the launch of the call;
- the technical contribution to the definition of the technical specification of the EU-RAIL – SESAR Synergy call for proposals (HORIZON-ER-JU-2023-FA1-SESAR) which is launched and administratively managed (grant management) by the EU-Rail JU.

- the technical contribution to the evaluation and award of the proposals, and then the technical supervision of the projects launched as a result of the DSD1 call for proposals (CEF-T-2021-SIMOBGEN), which is launched and administratively managed (grant management) by CINEA;
- the technical contribution to the definition of topics, call management, and the evaluation and award of proposals, and then the technical supervision of the projects launched as a result of the DSD1b call for proposals (CEF-T-2022-SIMOBGEN), which has been launched on 13 September 2022 and will be administratively managed (grant management) by CINEA.
- the technical contribution to the definition of topic of the DSD2 call for proposals (CEF-T-2023-SIMOBGEN), which will be launched in 13 September 2023 and will be administratively managed (grant management) by CINEA.

Figure 6 presents the scope of the first set of calls for proposals of the Digital European Sky programme. In particular, it shows how the different SRIA flagships are covered across the R&I pillars. It also presents the budget allocated per work area (WA).



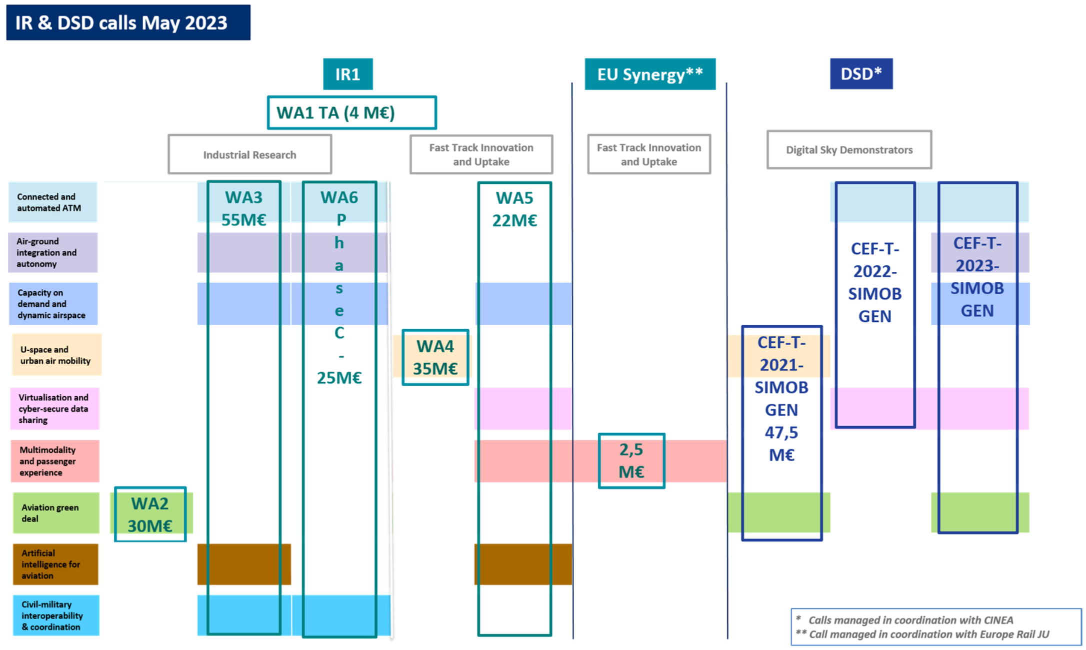


Figure 6: **Coverage of the SRIA flagships through the first set of calls for proposals of the Digital European Sky programme**

The topics of the calls and their full descriptions can be found in Annex II.

2.4 Calls for tender and other actions

As per Article 110 of the EU financial regulation ([10]), 'a budgetary commitment shall be preceded by a financing decision adopted by the Union institution or by the authority to which powers have been delegated by the Union institution'. This financing decision must set out certain essential elements for actions involving expenditure from the budget for procurement and prizes. The BAWP for 2022 and 2023 constitutes the financing decision for 2022 and, upon confirmation by the Commission, for 2023.

It should be noted that, in accordance with Article 110(5) of the EU financial regulation and the principle of sound financial management, the SESAR 3 JU authorising officer may decide to make non-substantial changes and amend the indicative budget or timing identified in Section 2.4.1 of this chapter for a given procurement procedure if this allows for improved adherence to the SESAR 3 JU's objectives. A change of more than 20 % in the volume of appropriations, the introduction of a new action or other changes affecting the political choices in the work programme are to be considered substantial.

The maximum global budgetary envelope reserved for procurements covered by operational appropriations is estimated to be a minimum of EUR 24 310 000 in 2022 and a minimum of EUR 2 260 000 in 2023.

2.4.1 Strategic area of operation 1 – Provide strategic steering to the SESAR 3 JU programme and the Digital European Sky programme

Reference	Budget line(s)	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Op1.1	4060	Transversal consultancy services	Provision of consultancy services to support the SESAR 3 JU in transversal steering, the facilitation of market uptake and outreach activities (for 4 years)	Q2 2023	2023	2 570 000	Framework contract / open call for tenders	Synergies with other joint undertakings will be sought
Op1.2	4000–4004	Expert call evaluations	Provision of technical expertise for the evaluation of calls for proposals	Q3 2022	2022	700 000	Expert contracts Interinstitutional call for expressions of interest	
Op1.3	4010	Experts for deliverables and project reviews	Provision of technical expertise for assessing the deliverables and contributing to the Horizon 2020 and Horizon Europe project review	Q4 2022	2022	350 000	Expert contracts Interinstitutional call for expressions of interest	Under Horizon 2020 funds

([10]) 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, 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.

Reference	Budget line(s)	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Op1.4	4030	Programme management support	Provision of SESAR 3 JU development support services to the SESAR 3 JU for SESAR 3 JU programme management	Q4 2022	2022	16 000 000	New framework contract / open call for tenders	4-year contract (renewable once) EUR 4 000 000 per year (2023–2030)
Op1.5	4001	Expert call evaluations	Provision of technical expertise for the evaluation of calls for proposals	Q3 2023	2023	350 000	Expert contracts Interinstitutional call for expressions of interest	
Total for strategic area of operation 1 – Provide strategic steering to the SESAR 3 programme and the Digital European Sky Programme – Year 2022						**EUR 17 050 000**		
Total for strategic area of operation 1 – Provide strategic steering to the SESAR 3 programme and the Digital European Sky Programme – Year 2023						**EUR 2 920 000**		

2.4.2 Strategic area of operation 2 – Deliver exploratory research

Reference	Budget line	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Op2.1	4140	Expert Scientific Committee	Secure the active support of the SESAR 3 JU Scientific Committee	Q2 2022	2022	480 000	Expert contract Call for expressions of interest	4-year contract EUR 120 000 per year
Total for strategic area of operation 2 – Deliver exploratory research – Year 2022						**EUR 480 000**		
Total for strategic area of operation 2 – Deliver exploratory research – Year 2023						**EUR 0**		

2.4.3 Strategic area of operation 3 – Deliver industrial research and validation

Reference	Budget line	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Total for strategic area of operation 3 – Deliver industrial research and validation – Year 2022								
Total for strategic area of operation 3 – Deliver industrial research and validation – Year 2023								

2.4.4 Strategic area of operation 4 – Facilitate an accelerated market uptake of SESAR Solutions

Reference	Budget lines	Procurement area	Procurement description	Target signature date	Budget years	Total estimated budget (EUR)	Type of contract/procedure	Comments
Op4.1	3400 (Horizon 2020) and 4330 (Horizon Europe)	Coordination with EASA	Implementation of the work plans for 2022 and 2023 under the SESAR 3 JU–EASA SLA	n/a	2022 and 2023	400 000		The SLA with EASA has already been signed and the implementation of the work plans for 2022 and 2023 requires only electronic approval The total amount (EUR 400 000) covers activities to be carried out in 2022 under Horizon 2020 funds (EUR 200 000) and in 2023 under Horizon Europe funds (EUR 200 000)
Total for strategic area of operation 4 – Facilitate an accelerated market uptake of SESAR Solutions – Year 2022						**EUR 200 000**		
Total for strategic area of operation 2 – Facilitate an accelerated market uptake of SESAR Solutions – Year 2023						**EUR 200 000**		

2.4.5 Strategic area of operation 5 – Deliver SESAR outreach (cooperation, synergies and cross-cutting themes and activities)

Reference	Budget line	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Op5.1	4400	Airspace users	Provision of advice services for civil airspace users to support SESAR 3 JU activities	Q1 2023	2023	1 600 000	New framework contract / open call for tenders	4-year contract to be broken down into lots (yearly maximum amount EUR 400 000)
Op5.2	4400	Airspace users	Provision of advice services for civil airspace users to support SESAR 3 JU activities	Q1 2023	2023	400 000	Specific contract under the framework contract	
Op5.3	4401	Professional staff organisations	Provision of professional staff organisation expertise for the execution of the SESAR 3 JU programme	Q1 2023	2023	1 200 000	New Framework contract/Open call for tenders	4-year contract to be broken down into lots (yearly maximum amount EUR 300 000)
Op5.4	4401	Professional staff organisations	Provision of professional staff organisation expertise for the execution of the SESAR 3 JU programme	Q1 2023	2023	300 000	Specific contract under the framework contract	
Op5.5	4402	Airport expertise	Provision of airport expertise for the execution of the SESAR 3 JU programme	Q4 2022	2022	250 000	Negotiated procedure	4-year contract with 1 specific contract each year (yearly maximum amount EUR 250 000) Increase by 50 % of the current framework contract
Op5.6	4402	Airport expertise	Provision of airport expertise for the execution of the SESAR 3 JU programme	Q4 2022	2022	250 000	Specific contract under the framework contract	
Op5.7	4402	Airport expertise	Provision of airport expertise for the execution of the SESAR 3 JU programme	Q4 2023	2023	1 000 000	New framework contract / open call for tenders	4-year contract 1 specific contract each year (yearly maximum amount EUR 250 000 from 2024)
Op5.8	4403	Young Scientist Award	Price for Young Scientist Award (including travel costs)	Q4 2022	2022	10 000	Award	
Op5.9	4403	Young Scientist Award	Price for Young Scientist Award (including travel costs)	Q4 2023	2023	10 000	Award	
Total for strategic area of operation 5 – Deliver SESAR outreach (Cooperation, synergies and cross-cutting themes and activities) –2022					**EUR 510 000**			

Reference	Budget line	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Total for strategic area of operation 5 – Deliver SESAR outreach (Cooperation, synergies and cross-cutting themes and activities) –2023						**EUR 4 510 000**		

Table 14: Main procurement activities to be conducted in 2022 and 2023 covered by operational appropriations

3 Support to operations of the SESAR 3 Joint Undertaking for 2022–2023

3.1 Objectives, activities, indicators and targets

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Promote the Digital European Sky vision, the added value of the SESAR 3 JU partnership, and innovation as an integral part of the EU's and industry's efforts to become economically and environmentally sustainable in the long-term	SESAR 3 JU virtual and physical events	Number of events hosted by the SESAR 3 JU	8	8
			Total number of attendees at events	200/event	200/event
		External events	Total number of externally hosted events with SESAR 3 JU representation	50	50
		SESAR 3 JU publications	Total number produced	3	4
		E-news and mailshots	Number of news items	24 news articles	30 news articles
			Number of newsletters/mailshots sent	15 newsletters/mailshots	20 newsletters/mailshots
		Digital communications: website	Website traffic	34 000 web visits	38 000 web visits
		Digital communications: social media	Number of posts (Twitter, LinkedIn)	700	900
		Digital communications: digital assets (e.g. animations, videos, playbacks, virtual reality experiences)	Number of assets produced	8	10
		External media	Number of physical and digital publications/articles contributed to	8 articles	12 articles

Objectives	Activities	Indicators	Target for 2022	Target for 2023
	Communications coordination	Number of meetings of the Communications Coordination Group	2 meetings, subject to the official launch of the group	2 meetings
Ensure full compliance with programming and reporting requirements	Execution of the programming requirements	Level of compliance with programming obligations for joint undertakings:	Full compliance	Full compliance
		• 2022–2023 BAWP submitted to the Governing Board for adoption by 17 March 2022	100 %	n/a
		• first amended 2022–2023 BAWP submitted to the Governing Board for timely adoption in 2023	100 %	100 %
		• 2024–2025 BAWP submitted to the Governing Board for timely adoption in 2023	n/a	100 %
	Execution of the reporting requirements	Level of compliance with reporting obligations for joint undertakings:	Full compliance	Full compliance
		• consolidated annual activity reports for 2021 and 2022 adopted by the Governing Board and timely sent to the budgetary authority	100 %	100 %
		• number of critical observations from auditors	0	0
		• number of files sent to the European Anti-Fraud Office for investigation	0	0

Objectives	Activities	Indicators	Target for 2022	Target for 2023
Monitor efficiency and effectiveness of legal and procurement activities	Provision of legal advice to the SESAR 3 JU on: • Horizon 2020 grants • Horizon Europe grants • other grants • other matters in relation to the European network with agencies and the Common Support Centre	Percentage of completed legal and procurement aspects of the contract action planning within deadlines	95 %	95 %
Deliver infrastructure services to enable teams and the SESAR 3 JU to operate smoothly	Maintenance of information technology (IT), infrastructure and facilities	Level of quality of IT, infrastructure and facilities and existence of business continuity and disaster recovery planning	No major disruption of service unless triggered under business continuity and disaster planning	No major disruption of service unless triggered under business continuity and disaster planning
Monitor efficiency and effectiveness of human resources management	career development review (CDR)	Level of completion of the CDR	95 %	95 %
	Objectives setting	Level of completion of objectives setting	80 %	90 %
	Reclassification exercise	Level of completion of the reclassification exercise	100 %	100 %
Efficient implementation of the human resources legal framework	• Activation of opt-out through the Governing Board • Adoption of implementing rules or Commission decisions through the Governing Board	Level of implementation of opt-out from Commission implementing decisions and models	100 %	100 %

Table 15: Objectives, activities, indicators and targets for support to operations in 2022 and 2023

3.2 Communication, dissemination and exploitation

3.2.1 Communication

Communication plays an integral role in building trust, securing buy-in and maintaining momentum for the SESAR 3 JU's R&I activities. It is also key for accelerating innovation and the implementation of SESAR solutions. The following table provides an overview of the SESAR 3 JU communications objectives and their corresponding actions, audiences and key messages.

For full details of the planned approach, activities and channels, see the SESAR 3 JU communications strategy for 2021–2026[11].

Objectives	Actions	Target audiences	Messages
Promote the Digital European Sky vision	Ensure programme coherence – implement a process to ensure that projects promote their objectives and results as part of the overall Digital European Sky programme and in line with Horizon Europe obligations	The SESAR 3 JU community	The SESAR 3 JU takes a holistic look at ATM modernisation, ensuring coherency and synergies between solutions, with a view to delivering the Digital European Sky
	Showcase solutions – illustrate that the digital European sky programme is developing solutions that can deliver tangible benefits to aviation, the economy and society		
Promote the role of the SESAR 3 JU partnership in creating added value	Deliver value for money as a coordinated R&I ecosystem under a partnership – showcase the role of the SESAR 3 JU partnership in ensuring a coherent R&I programme fulfilling industries' performance needs	Policymakers/decision-makers	The SESAR 3 JU as a public–private partnership is the most effective and cost-efficient instrument to deliver an integrated and modernised R&I ecosystem for ATM within Horizon Europe. It offers the best means to build consensus and coordinate stakeholders, pooling a critical mass of resources and expertise
	Enable global interoperability – promote SESAR solutions within the ICAO and third countries to ensure global interoperability, to facilitate EU exports and to gain a competitive edge internationally	Stakeholders beyond the SESAR 3 JU	The SESAR 3 JU cooperates internationally to enhance global harmonisation and promote EU innovation and competitiveness

[11] The SESAR 3 JU communications strategy for 2021–2026 will be adopted by the Governing Board in 2022.

	Promote new talent – embrace disruptive technologies and unlock change by supporting and encouraging new talent entering the ATM/aviation ecosystem	Policymakers/decision-makers	The SESAR 3 JU extends the partnership to academia, SMEs and start-ups to consolidate and enrich the R&I network of talent
Promote SESAR R&I as an integral part of the EU's and industry's efforts to become economically and environmentally sustainable in the long term	Ensure alignment with European policy – support the delivery of EU initiatives on mobility, digitalisation and sustainability	Policymakers/decision-makers	The SESAR 3 JU supports the delivery of the digital European sky programme. It is a key element of several EU policy agendas: the sustainable and smart mobility strategy , the European Green Deal and the 'Europe fit for the digital age' initiative
	Contribute to societal needs – promote the knock-on benefits that SESAR R&I will bring to passengers and citizens	The general public	The SESAR 3 JU supports improvements to ATM that have knock-on benefits for EU citizens, namely supporting the EU's economic growth, reducing environmental impacts and improving passenger experience through enhanced transport connectivity and multimodality
	Explain the R&I life cycle (the 'innovation pipeline') – illustrate how the SESAR approach helps to accelerate the development of innovative ideas from inception to implementation through a range of R&I instruments	The SESAR 3 JU community	The SESAR 3 JU promotes research excellence with a focus on transforming initial concepts into tangible solutions for market uptake, including as part of the new SESAR 3 JU Digital Sky Demonstrators, which support early movers
	Boost performance and respond to challenges – showcase how R&I can adapt to evolving trends and challenges, and its role in meeting performance ambitions	The SESAR 3 JU community	The SESAR 3 JU delivers solutions capable of boosting the performance of ATM/aviation. The solutions respond to evolving challenges, with a strong emphasis on sustainability and accommodating new airspace users
Strengthen internal communications with SESAR 3 JU staff	Foster staff engagement and commitment to the SESAR 3 JU values and objectives – nurture a spirit of belonging to the organisation and support SESAR 3	SESAR 3 JU staff	The SESAR 3 JU is an open and inclusive partnership that values its staff and their well-being and that fosters their active

	JU staff in becoming brand ambassadors for the Digital European Sky		contribution to delivering the Digital European Sky
	Keep staff up to date on the key priorities and activities of the SESAR 3 JU – make use of communications channels to inform staff of the latest developments/achievements of the partnership		

Table 16: Overview of the SESAR 3 JU communications' objectives, actions, audiences and key messages

In 2022 and 2023, the focus of the SESAR 3 JU's communication activities will be:

- familiarising audiences with the new partnership, executive director and programme;
- promoting SESAR R&I in relation to key policy areas;
- showcasing results and solutions delivered by ongoing R&I;
- providing guidance to members and projects on their obligations and commitments to communicating about projects within the framework of the partnership and programme.

The following table provides an overview of the major events and conferences in 2022 and 2023 in which the SESAR 3 JU expects to invest significant resources. However, it should be noted that various other conferences and events organised by the EU and by European and international stakeholders might require the SESAR 3 JU's participation through speakers, workshops or exhibition stands.

Event name	Location	Date	Organiser	Comments
SESAR 3 JU launch event	Brussels	5 May 2022	SESAR 3 JU	A high-level event 'hosted' by Commissioner Valean to mark the launch of the new SESAR 3 JU. Invitees will include Governing Board members and CEOs from participating members, as well as high-level representatives from core stakeholders
SESAR 3 JU internal meeting	Madrid	20 June 2022	SESAR 3 JU	A gathering of the SESAR 3 JU members to showcase the latest achievements and inform them of upcoming activities
World ATM Congress	Madrid	21–23 June 2022	CANSO / Air Traffic Control Association	Participation on the 'Europe for aviation' stand, including exhibitions, speeches/presentations and press outreach opportunities
SESAR 3 JU annual conference	Brussels	TBD	SESAR 3 JU	An annual gathering of the SESAR community and

				policymakers to discuss aviation challenges and highlight the SESAR 3 JU programme milestones and showcase the latest achievements. The conference will also be used as a backdrop to present the SESAR 3 JU project awards
U-space showcase event	Brussels	TBD	SESAR 3 JU	A conference dedicated to showcasing the results of the SESAR 2020 U-space projects
12th **SESAR Innovation Days**	Budapest	6–8 December 2022	SESAR 3 JU	A week-long conference of exhibitions, networking and other activities (e.g. poster pitches and industry site visits)
Events in collaboration with institutional and stakeholder partners (up to four per year)	TBD	2022 + 2023	SESAR 3 JU and partners	Exhibitions and/or workshops to promote the value of the public–private partnership approach and the results from SESAR that target stakeholder and institutional audiences
Digital events (webinars/vodcasts)	Virtual	Q1 2022–Q4 2023	SESAR 3 JU	Virtual events including presentations and discussions about SESAR projects, solutions and results, for amplifying the SESAR 3 JU vision
Internal team-building event	Brussels (TBC)	Q1 2022–Q4 2023	SESAR 3 JU	Annual events aiming to foster a team spirit among SESAR 3 JU staff
Airspace World	Geneva	8–10 March 2023	Air Traffic Control Association / CANSO	Participation on the 'Europe for aviation' stand, including exhibitions, speeches/presentations and press outreach opportunities
Paris Air Show	Paris	19–25 June 2023	Groupement des Industries Françaises Aéronautiques et Spatiales (GIFAS)	Exhibitions and/or workshops to promote the SESAR 3 JU vision and achievements
SESAR 2020 showcase	Brussels (TBC)	TBD–Q3 2023	SESAR 3 JU	A showcase of the results of SESAR 2020, to take place in 2023
13th SESAR Innovation Days	TBD	TBD–Q4 2023	SESAR 3 JU	A week-long conference of exhibitions, networking and other activities (e.g. poster pitches and industry site visits)

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Table 17: Key events and conferences for SESAR 3 JU in 2022 and 2023

The following table represents the publications, digital communications and communications coordination currently planned for 2022 and 2023.

Activity	Date
Publications	
Application of the SESAR3 JU visual identity (print material: posters, visual graphics, etc.)	Q1–Q4 2022–2023
SESAR innovation pipeline – R&I highlights	Q1 2022 and Q1 2023
Consolidated annual activity reports	Q2 2022 and Q2 2023
Exploratory research results brochure	Q4 2022
SESAR solutions catalogue – web portal launch brochure	Q3 2023
Various brochures/factsheets on SESAR 2020 and SESAR 3 JU R&I (e.g. performance, environment, solutions, results)	Q1–Q4 2022–2023
Digital communications	
Digital assets (e.g. thematic portals, videos, animations, virtual reality, augmented reality and gaming)	Q1–Q4 2022–2023
Online communications	
E-news (interviews and project news)	Q1–Q4 2022–2023
Contributions to external magazines	Q1–Q4 2022–2023
Press relations	Q1–Q4 2022–2023
Social media campaigns	Q1–Q4 2022–2023
Communications coordination	
Online and face-to-face meetings with the Communications Coordination Group	Q1–Q4 2022–2023
Project guidance, communications plan reviews and monitoring progress	Q1–Q4 2022–2023

Table 18: Main publications and communication activities in 2022 and 2023

3.2.2 Dissemination and exploitation

The SESAR 3 JU will continue to implement actions aimed at raising awareness among beneficiaries about the importance of dissemination of projects' results. The activities are tailored to the specific situations of the projects, depending on the different projects' implementation stages.

Besides continuous monitoring of the dissemination activities related to the projects performed by the members and the partners, during the implementation of these activities (according to the applicable periodicity and certainly at the final reporting stage), the SESAR 3 JU will ensure that the requirements of the grant agreements in this regard are met.

Finally, the SESAR 3 JU has appointed a dissemination, exploitation and communication correspondent within the grant management team. In this capacity, the correspondent is responsible for providing training sessions on dissemination and exploitation for grant managers and programme managers at the SESAR JU, as well as providing feedback to colleagues in the team on specific requests related to dissemination and exploitation.

The correspondent also attends the meetings of the Communication Coordination Group (made up of communication experts among the members) to promote the need for disseminating the projects' results.

3.3 Procurement and contracts

For 2022–2023, the SESAR 3 JU will assign the necessary funds for the procurement of the services and supplies required to sufficiently support its administrative and operational infrastructures. Summary tables per areas of operation are made available below listing the tenders planned for 2022–2023.

3.3.1 Communication, dissemination and exploitation

Reference	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Ad5.1	Public relations (PR)	Events	Q1 2022	2022	150 000	Framework contract, implementation of inter-institutional procurement procedure	Visibility at aviation events and air shows, as well as internal SESAR 3 JU events
Ad5.2	PR	Digital communication	Q1 2022	2022	88 500	Framework contract, implementation of inter-institutional procurement procedure	Animations
Ad5.3	Web (budget line 2740)	Hosting, maintenance and content management	Q1 2022	2022	94 681.50	Framework contract, inter-institutional procurement procedure	First specific contract of SESAR JU procurement
Ad5.4	Web (budget line 2740)	Hosting, maintenance and content management	Q2 2022	2022	30 318.50	Direct service contract	
Ad5.5	PR	Strategy and support	Q2 2022	2022	79 600	Framework contract, inter-institutional procurement procedure	Social media, press and copyrighting support
Ad5.6	PR	Events	Q3 2022	2022	185 000	Framework contract, inter-institutional procurement procedure	Visibility at aviation events and air shows, as well as internal SESAR 3 JU events
Ad5.7	PR	Strategy and support	Q4 2022	2022	20 400	Framework contract, inter-institutional procurement procedure	Social media, press and copyrighting support
Ad5.8	PR	Office of publications	Ad hoc – 2022	2022	6 000	SLA	Editorial, graphical work and printing

Reference	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Ad5.9	PR	Small procurement	Ad hoc – 2022	2022	10 000	Payment against invoices, purchase orders, direct service, supply contracts	Procurement of very-low-value items – items to be paid against invoices (very low procurements)
Ad5.10	PR	Event support for the SESAR showcase event	Q2 2023	2023	200 000	Direct service contract, open call for tenders	
Ad5.11	PR	Events	Q1 2023	2023	130 000	Framework contract, inter-institutional procurement procedure	Visibility at aviation events and air shows, as well as internal SESAR 3 JU events
Ad5.12	PR	Digital communications	Q1 2023	2023	75 300	Framework contract, inter-institutional procurement procedure	Animations
Ad5.13	Web (budget line 2740)	Hosting, maintenance and content management	Q1 2023	2023	125 000	Framework contract, inter-institutional procurement procedure	Second contract of SESAR JU procurement
Ad5.14	PR	Events	Q3 2023	2023	125 000	Framework contract, inter-institutional procurement procedure	Visibility at aviation events and air shows, as well as internal SESAR 3 JU events
Ad5.15	PR	Strategy and support	Q2 2023	2023	50 000	Framework contract, inter-institutional procurement procedure	Social media, press and copyrighting support
Ad5.16	PR	Office of publications	Ad hoc – 2023	2023	10 000	SLA	Editorial, graphical work and printing
Ad5.17	PR	Small procurement	Ad hoc – 2023	2023	10 000	Payment against invoices, purchase orders, direct service, supply contracts	Direct procurement for very-low-value items – items to be paid against invoices (very low procurements)
Ad5.18	PR	Strategy and support	Q4 2023	2023	50 000	Framework contract, inter-institutional procurement procedure	Social media, press and copyrighting support

Reference	Procurement area	Procurement description	Target signature date	Budget year	Total estimated budget (EUR)	Type of contract/procedure	Comments
Total for communication and dissemination – 2022					**EUR 664 500**		
Total for communication and dissemination – 2023					**EUR 775 300**		

3.3.2 Deliver effective financial, administrative and corporate management

Reference	Procurement area	Procurement description	Target signature date	Budget year	Total est. budget (EUR)	Type of contract/procedure	Comments
Ad6.01	Information and communications technology (ICT) – software	ICT software – Adobe maintenance renewal	Q1 2022	2022	17 550	Specific contract under the European Commission framework contract	
Ad6.02	ICT – software	ICT software – VMware maintenance renewal	Q1 2022	2022	1 734	Specific contract under the European Commission framework contract	
Ad6.03	IT system maintenance and unified communication	ICT communications – Testa-NG	Q1 2022	2022	23 000	Specific contract under the European Commission framework contract	
Ad6.04	Joint undertakings' back office	Study to explore possible efficiency gains in a back-office arrangement approach	Q2 2022	2022	20 000	Inter-institutional procurement	Although the back-office arrangement shall be provided by EUROCONTROL, it is in the interest of SESAR 3 JU to join the other joint undertakings in this common study to investigate opportunities for achieving efficiencies and gains in particular in areas where back office services cannot be provided by EUROCONTROL (e.g. due to their different governing rules).

Ad6.05	ICT coordination	ICT Coordination & Quality management service	Q4 2022	2023	2 200 000	Direct Service Contract – Open call for tender	New call for tender. 4 years contract (renewable once). EUR 550 000 per year (April 2023- April 2027). Current ICT Coordination services contract expires March 2023. Transition required.
Ad6.06	ICT – software	ICT software – Adobe maintenance renewal	Q1 2023	2023	16 500	Specific contract under the European Commission framework contract	
Ad6.07	ICT – software	ICT software – VMware maintenance renewal	Q1 2023	2023	2 000	Specific contract under the European Commission framework contract	
Ad6.08	IT system maintenance and unified communication	ICT communications – Testa-NG	Q1 2023	2023	25 000	Specific contract under the European Commission framework contract	
Total for delivering effective financial, administrative and corporate management – 2022						**EUR 62 284**	
Total for delivering effective financial, administrative and corporate management – 2023						**EUR 2 243 500**	

Table 19: Main procurement activities to be conducted in 2022 and 2023 covered by administrative appropriations

3.4 Other support operations

3.4.1 Legal and procurement support for operations

In the field of legal and procurement support for operations, and in continuation with activities carried out over recent years, in 2022 and 2023 the SESAR 3 JU will carry out the following actions.

For legal affairs

- Develop legal analysis on various matters requiring it. This analysis aims to ensure:
    - the regularity and legality of all of the SESAR 3 JU's binding agreements, contracts, grants, decisions, processes and measures;
    - compliance of the agreements to be concluded with the SESAR 3 JU's founding members (including the membership agreement, the administrative agreement with EUROCONTROL and the financial framework partnership agreement) with the Single Basic Act;
    - coherence between the different agreements concluded with the SESAR 3 JU's founding members (delegation agreements with the European Commission and the agreement with EUROCONTROL);
    - appropriate support for the activities aimed at defining the future of SESAR.
- Such analysis could take the form of:
    - legal advice, opinions, legal risk assessments and related mitigation actions;
    - the drafting of agreements and legal documents required for ramping up the SESAR 3 programme (including rules of procedures for SESAR 3 JU advisory bodies, a dedicated call for expressions of interest and Governing Board decisions) in strict compliance with the Single Basic Act and applicable regulations;
    - participation in the SESAR 3 JU's technical and administrative projects;
    - drafting, reviewing or updating SESAR 3 JU staff training activities, guidelines or other material on legal matters including the SESAR 3 JU's internal rules and procedures.
- Coordinate with the European Commission and relevant SESAR 3 JU external stakeholders with regard to legal aspects of:
    - the implementation of the SESAR 2020 programme activities;
    - any measure related to the transition towards the new multiannual financial framework;
    - the development and implementation of the programme and administrative closure/transition scenarios, including the potential liquidation of the SESAR 3 JU in its current form, the transfer of tangible and intangible assets and any other topics requiring legal expertise;
    - the impacts of the late association of some countries to Horizon Europe (e.g. Switzerland and the United Kingdom).
- Support the internal SESAR 3 JU ramp-up transversal coordination mechanisms aimed at identifying any risk of hampering the SESAR 3 JU daily output, collectively seeking solutions in line with commonly defined ramp-up strategies and objectives.

- Participate in interagency legal and procurement networks (the Inter Agencies' Legal Network and the Network of Agencies' Procurement Officers) as well as in Horizon Europe legal networks (the Legal Mechanism Issue Group and the Common Implementation Centre ad hoc meetings) in order to contribute to the implementation and development of these networks' annual work programmes, concerted guidance, processes and templates.

For procurement

- Provide legal and procedural support and advice for the effective implementation of the procurement plan for 2022 and 2023 (see section 2.4. and section 3.3. of this document): preparation, launch and administration of procurement procedure files and contracts.
- Develop legal and procedural analysis on various matters requiring it in the field of procurement in view of the rules and regulatory framework applicable to SESAR 3 JU procurement and contract management. Such analysis could take the form of legal advice, legal risk assessments and related mitigation actions, SESAR 3 JU staff training activities, guidelines or other material on procurement matters as well as drafting, review and/or update of the SESAR 3 JU's internal rules and procedures related to procurement activities.
- Promote automation in the management of procurement and contracts (i.e. e-procurement).
- Liaise with other joint undertakings and EU agencies in relation to interinstitutional joint procurement and for the creation of synergies between joint undertakings.

3.4.2 Corporate planning and reporting activities

The SESAR 3 JU will submit the MAWP for 2021 to 2031 to the Governing Board by mid February 2022 for adoption in March 2022.

The SESAR 3 JU will prepare, develop and submit the 2022–2023 BAWP to the Governing Board by mid February 2022 for adoption in March 2022. This submission will be preceded by a consultation with the States' Representatives Group, which should deliver its opinion on the 2022–2023 BAWP by mid February.

In addition, the SESAR 3 JU will prepare three implementation reports for 2021, which present the activities undertaken by the SESAR 3 JU during that year to implement the delegation agreements ([12]) between the European Commission and the SESAR 3 JU.

Finally, the SESAR 3 JU will develop its *Consolidated Annual Activity Report 2021* and submit it to the Budgetary Authority by 30 June 2022.

3.4.3 Data protection

Since the entry into force of Regulation (EU) 2018/1725 ([13]), the SESAR 3 JU's long-term commitment to a privacy practice and culture has been strengthened.

([12]) These delegation agreements relate to geofencing (MOVE/E3/DA/2016-669/SI2.743803), airspace architecture (MOVE/E3/DA/2017-477/SI2.766828) and U-space (MOVE/E3/DA/2017-564/SI2.771010).

([13]) 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, OJ L 295, 21.11.2018, p. 39.

The SESAR 3 JU will continue adapting its processes and ICT tools when used for processing personal data. This will help to demonstrate accountability in line with Regulation (EU) 2018/1725.

Whereas most of the novelties and requirements of Regulation (EU) 2018/1725 have been tackled by the SESAR 3 JU through the implementation and monitoring of the action plan, a number of ongoing actions are to be performed in the upcoming years in line with the main principles of:

- accountability and the shift of responsibilities from the data protection officer to the controller responsible for compliance at three levels (insurance, demonstration and verification);
- documentation and consultation obligations closely tied to the risks;
- transparency and the provision of clear information to data subjects, allowing data subjects to effectively exercise their rights;
- the obligation on the part of the SESAR 3 JU to notify the supervisory authority of personal data breaches;
- strict data protection measures for procurement and contract management.

For this purpose, the SESAR 3 JU will continue to implement the following recurring activities:

- plan, provide advice and report to the controller on accountability at three levels: (1) participation in the Quality and ICT (QICT) Committee meetings, (2) constant monitoring of the SESAR 3 JU action plan on data protection and (3) regular reporting obligations to the European Data Protection Supervisor (EDPS);
- provide advice on ad hoc requests from data subjects and process access requests in due time;
- record and map all transfers of personal data through the update and population of the electronic records system (general data protection regulation central system) and privacy notices;
- implement data protection by design and by default in the definition of new services and tasks by introducing data protection requirements for procurement procedures at three different levels (definition, evaluation and reporting) and in the resulting contracts;
- draft SESAR 3 JU policies and internal rules on data protection, notably on data breaches, impact assessment and access requests;
- review the SESAR 3 JU decision on restrictions every 2 years and assess every 6 months each restriction in place and report to the Governing Board;
- provide advice on and coordinate data protection impact assessments and consult the EDPS when necessary;
- report and document any identified data breach and, when necessary, send notifications to the EDPS and affected data subjects;
- continue the drafting exercise for the internal rules of the SESAR 3 JU on data protection throughout 2022;
- contribute to and follow up on developments in joint controllership;
- cooperate with EUROCONTROL’s data protection officer;
- disseminate information across the SESAR 3 JU.

The following specific actions are planned during 2022 and 2023 in terms of readiness for closer cooperation with EUROCONTROL:

- final drafting of the data processing agreement between the SESAR 3 JU and EUROCONTROL;
- mapping the processing of personal data for the new tasks of EUROCONTROL in the light of Article 157 of the Single Basic Act;
- the internal publication and application of SESAR 3 JU specific procedures for data breaches and impact assessments;
- the publication in the Official Journal of the Governing Board decision on restrictions of data subjects' rights;
- the introduction of data processing agreements as annexes to procurement contracts, with an impact on data protection, in the application of the standard contractual clauses published by the European Commission;
- the preparation and coordination of the data protection impact assessment in Microsoft Office 365 in close cooperation with the SESAR 3 JU local information security officer, IT services and EUROCONTROL;
- following up on negotiations between the European Court of Justice and Cisco Webex for the implementation of the 14 recommendations of the EDPS;
- dissemination activities and information sessions on data breaches and restrictions for all staff.

3.4.4 Information and communications technology management

ICT services and infrastructure will continue to be provided to the SESAR 3 JU under a signed service agreement by EUROCONTROL, delivered by the NM (responsible for contracting and organising ICT services and infrastructure for all EUROCONTROL divisions). The details of the scope of services, assets and management of change are defined based on the individual service, requests, offers and agreements covering the scope and financial liability (contribution) delivered for the SESAR 3 JU. An architecture model and appropriate security arrangements are maintained to ensure adequate information segregation while ensuring that the SESAR 3 JU benefits from the economy of scale.

In addition to services from EUROCONTROL, the SESAR 3 JU also uses some services and common procurement, under an SLA, with the European Commission's Directorate-General for Informatics to ensure the full scope of functionality required is delivered to staff.

To coordinate and provide a local focal point, the SESAR 3 JU continues to outsource (via a services contract) an independent coordination service (ICT coordination services) in the SESAR 3 JU that is responsible for planning and coordinating delivery, upgrade and change projects, as well as being the focal point on ICT matters for staff and other suppliers. The ICT coordination services will continue to support SESAR 3 JU corporate governance and staff by:

- providing expert advice and input in the fields of ICT, unified communications and business continuity management;
- providing a stable and continuously accessible teleworking infrastructure;
- ensuring minimal interruptions to service and the continuity of support arrangements acting as an interface with ICT suppliers (EUROCONTROL subcontractors).

During the reporting period, continuous care will be taken to ensure that the ICT infrastructure and the operating environment are suitable to meet the needs and budget of the SESAR 3 JU. The configuration is controlled through internal governance (the QICT Committee), with deviations described through change requests or in transformation projects. Service-level measurement and performance improvement activities will be safeguarded by service improvement requests and problem management.

During 2023, the services contract, including ICT coordination, will be reviewed in preparation for a new call to secure the continuity of services and options for an extension of the scope, which will be ready for transition in Q1 2024.

3.4.5 Facility and support services

Facility and support service activities are related to the following administrative tasks and services:

- facilities management coordination, supporting all persons working and/or providing services within the SESAR 3 JU premises, by providing facility coordination support in the buildings and logistics services;
- mission coordination, supporting SESAR 3 JU staff by providing core support for their travel bookings and the execution of missions, and for the reimbursement of travel expenses, namely the travel agency’s expenses and the traveller’s claims;
- insurance coordination, ensuring necessary coverage against recognised operational risks and the follow-up of new insurance claims.

In 2022 and 2023, in terms of facilities management, work will continue on a number of initiatives at the SESAR 3 JU’s premises in Brussels to sustain or improve the productivity, safety and efficiency of the working environment and the facilities offered to SESAR 3 JU staff. In particular, the SESAR 3 JU will:

- start the preparation of a new ongoing public procurement call for tenders in relation to reception and back-office reception services;
- publish a public procurement call for tenders in relation to the security services alarm monitoring, badging and video surveillance systems;
- continue its ongoing public procurement call for tenders in relation to cleaning services;
- depending on the evolution of the COVID-19 crisis, extend or implement measures to monitor the occupancy levels and the presence of the staff at the SESAR 3 JU’s premises, based on the rules and recommendations of the European Commission and the Belgian authorities.

During the 54th SESAR JU Administrative Board in October 2021, EUROCONTROL mentioned the willingness of this organisation to host the new premises of the SESAR 3 JU. Therefore, in 2022 and 2023, the facility will:

- perform assessments in view of the possible change of premises of the SESAR 3 JU, including a comparison of the different options for changing SESAR 3 JU premises, external assessments (an opportunity study, a commuting study and the evaluation of the cost of reestablishment of the premises) and staff assessments (a staff survey); the results of all of the assessments undertaken in view of the possible change of premises of the SESAR 3 JU will be gathered in a report to provide the SESAR 3 JU Governing Board with all of the inputs to facilitate an informed decision being taken on this topic;

- in the case of a change of premises of the SESAR 3 JU, coordinate the move and provide administrative and logistics support.

Mission support will also continue during 2022 and 2023, consisting of mission process management and support for all staff across the SESAR 3 JU while contributing to continuous improvement initiatives relating to the mission system or the electronic workflow. Mission budget execution monitoring will be put in place, with periodic reports submitted to the corporate management team of the SESAR 3 JU.

3.5 Human resources

3.5.1 Human resources management

3.5.1.1 ***Recruitment and management of human resources***

Following the Single Basic Act, the body of staff of the SESAR 3 JU consists of temporary agents (TAs) and contract agents (CAs) recruited for a fixed period, whose position may be renewed once for a fixed period of up to 5 years. Any other renewal must be for an indefinite period in accordance with the EU's staff regulations. The total period of engagement must not in any case exceed the duration of the SESAR 3 JU.

The staff of the SESAR 3 JU must consist of highly specialised technical staff members in charge of the management and implementation of the SESAR 3 JU programme and highly specialised and diversified administrative staff to ensure the functioning of the SESAR 3 JU. In establishing the different job descriptions and the organisation chart of the SESAR 3 JU, particular attention is paid to preserving the separation of functions, managing the risk of conflicts of interest and ensuring the efficient and cost-effective operation of the organisation.

It has to be recognised that it is difficult to attract highly skilled persons on TA contracts for a limited duration, given the time frame indicated in the SESAR 3 JU founding act.

3.5.1.1.1 Statutory staff recruitment policy

The SESAR 3 JU launches recruitment procedures for TAs through the announcement of vacant posts on its website and the website of the European Personnel Selection Office. The SESAR 3 JU may also recruit CAs from the European Personnel Selection Office's reserve lists, for the specific needs identified above.

Generally, vacancies are online for 1 month, during which time candidates can submit their applications. Exceptionally, this period may be extended. The exact deadline for applying for a job is indicated in the vacancy notice of the selection procedure, which also provides information on the job requirements and the conditions of employment. Candidates are requested to submit their application exclusively by means of a functional email address specific to each vacancy notice.

The eligibility of candidates is assessed according to compliance with all formal requirements by the closing date for the submission of applications. Eligible candidates whose applications show evidence of all of the essential selection criteria described in the vacancy notice may be invited for an interview, which is held for the most part in English. During the selection process, candidates may be required to undergo a competency assessment exercise.

Candidates invited to an interview are requested to submit, on the day of the interview, a copy of their diploma(s) and evidence of their professional experience, clearly indicating the starting and finishing dates, the function(s) and the exact nature of the duties carried out. However, prior to the signature of the contract, selected candidates are requested to provide the SESAR 3 JU with original or certified copies of all relevant documents proving they meet the eligibility requirements.

As a result of the interviews, the selection panel recommends the most suitable candidates for the post in question. The list of suitable candidates established by the selection panel may also be used for the recruitment of a similar post, depending on the needs of the SESAR 3 JU. All candidates are informed by letter about the outcome of the selection procedure. Candidates are informed that inclusion on a reserve list does not guarantee recruitment.

The selection panel's work and deliberations are strictly confidential, and candidates are informed that any contact with its members is strictly forbidden.

The Executive Director, namely the appointing authority of the SESAR 3 JU, takes the final decision to offer the job to a selected candidate from the reserve list established by the selection panel.

Officials

The SESAR 3 JU has no permanent posts in its establishment plan and, therefore, cannot appoint officials.

Temporary agents

On the basis of the missions and tasks set out by the SESAR 3 JU basic act ([14]), most of its existing workforce is assigned to long-term posts, within the limits of the existence of the SESAR 3 JU, both in the operational areas and in the transversal areas.

All TA posts have been identified as posts of long duration, and selected candidates are offered limited duration contracts (except for staff who were under Belgian contracts as at 1 January 2009, in accordance with the transition provisions of Council Regulation (EC) No 1361/2008, who are under indefinite duration contracts still subject to the end of functioning of the SESAR 3 JU on 31 December 2031 at the latest).

The recruitment process followed complies with the European Commission's rules on the engagement and use of temporary staff. The entry grades are determined with regard to the complexity and level of responsibility of the tasks to be performed by the new staff member. These grades are compatible with the provisions of Article 53 of the conditions of employment of other servants of the European Union, with the corresponding implementing rules on the engagement of TA 2(f) positions and with the grades authorised by the European Commission in the SESAR 3 JU's staff establishment plan.

Concerning specific recruitment processes such as recruitment processes for TA 2(a) positions, such as the Executive Director position, the selection process is managed by the parent Directorate-General, the Directorate-General for Mobility and Transport.

Contract agents

The SESAR 3 JU's staff establishment plan contains one CA position.

([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), OJ L 64, 2.3.2007, p. 1, as amended by Council Regulation (EC) No 1361/2008 of 16 December 2008, OJ L 352, 31.12.2008, p. 12, and by Council Regulation (EU) No 721/2014 of 16 June 2014, OJ L 192, 1.7.2014, p. 1.

Seconded national experts
In relation to requirements for specific expertise, the SESAR 3 JU recruits seconded national experts from competent national organisations in the EU Member States, especially where expertise within regulators, public authorities or other public bodies is desirable.

European Commission implementing rules relating to the recruitment of staff
The table below provides an overview of the relevant European Commission implementing rules relating to the recruitment of staff, as applied by the SESAR 3 JU.

Subject matter	Decision number	Applied by the SESAR 3 JU		If no, which other implementing rules are in place?
		Yes	No	
Engagement of CAs	Model Decision C(2019) 3016	X		
Engagement of TAs	Model Decision C(2015) 1509	X		
Middle management	Model Decision C(2018) 2542	X		
Type of post	Model Decision C(2018) 8800		X	C(2013) 8979

Table 20: Implementing rules relating to the recruitment of staff applied by the SESAR 3 JU

3.5.1.1.2 Other human resources managed by the SESAR 3 Joint Undertaking

Interim services acquisition
The SESAR 3 JU has the capacity to engage interim staff on a temporary basis and on short-term contracts through temping agencies in either of the following cases:

- the necessary replacement of TAs or CAs in a situation of their long-term absence, and for the duration of such an absence;

  or

- unforeseen additional tasks implying a level of additional workload that cannot be carried out by the existing TAs and CAs.

For these cases, the SESAR 3 JU uses a framework contract (reference HR/R1/PR/2019/023), for the period 1 July 2020 to 30 June 2024. The budget available for this procurement is equivalent to six full-time equivalents (FTEs) per year during a 4-year period.

Blue book trainees
The SESAR 3 JU has the capacity to offer traineeships to blue book trainees through the SLA signed with the European Commission. The maximum capacity of the SESAR 3 JU to host blue book trainees, in accordance with the SLA, is four trainees per traineeship period.

Atypical trainees
The SESAR 3 JU occasionally engages atypical trainees for short-term traineeships, without a financial impact for the SESAR 3 JU. Since 2021, the template and rules to engage atypical trainees, harmonised with those used by the European Commission, are available.

3.5.1.1.3 External personnel working for the SESAR 3 Joint Undertaking in-house

Structural service providers
For the purposes of managing, planning and controlling reception services, in 2011 the SESAR 3 JU signed a 1-year renewable contract with a service provider. This service provider provides one or two FTEs as receptionists / back-office reception staff. It is not always the same person providing the services. In terms of ICT coordination, one person is provided by an external service provider. There is no contractual relation at all between the persons appointed by the service providers to provide these services and the SESAR 3 JU, as it is important that these persons have no link with SESAR 3 JU human resources matters.

Seconded staff from SESAR Joint Undertaking selected members
At its meeting on 31 May 2017, the Administrative Board of the SESAR JU, having regard to Article 5(1)(p) and Article 8 of the annex to the SESAR JU basic act and the SESAR JU membership agreement, which entered into force on 6 July 2017 and was signed by the SESAR JU, EUROCONTROL and the SESAR JU's 19 selected members by virtue of Decision ADB(D)02-2016, decided:

- to adopt specific conditions on the secondment of staff of SESAR JU selected members, as detailed in Annex 1 to Decision ADB(D)07-2017;
- to delegate the power to the Executive Director to establish the necessary agreements in line with the aforementioned conditions.

Currently, two secondees are working at the SESAR JU under the abovementioned framework.

Secondment to the SESAR 3 JU is subject to the signing of a secondment agreement. This possibility will end on 31 December 2022, as the related Administrative Board decision will no longer be valid.

3.5.1.2 *Appraisal of performance and reclassification/promotions*

Implementing rules in place.

Subject matter	Decision number	Applied by the SESAR 3 JU		If no, which other implementing rules are in place?
		Yes	No	
Reclassification of TAs	Model Decision C(2015) 9560	X		
Reclassification of CAs	Model Decision C(2015) 9561	X		
Appraisal of TAs	Model Decision C(2013) 8985	X		
Appraisal of CAs	Model Decision C(2014) 2226	X		

Table 21: Implementing rules related to reclassification/promotions applied by the SESAR 3 JU

3.5.1.2.1 *Reclassification of temporary staff /promotion of officials*

Grade	Average seniority in the grade among reclassified staff											
	No of reclassified staff	Average seniority in 2017 (year N – 5)	No of reclassified staff	Average seniority in 2018 (year N – 4)	No of reclassified staff	Average seniority in 2019 (year N – 3)	No of reclassified staff	Average seniority in 2020 (year N – 2)	No of reclassified staff	Average seniority in 2021 (year N – 1)	Actual average over 5 years (N – 5 to N – 1)	Average over 5 years (according to Decision C(2015) 9563)
AD5	1	2.0									2.0	2.8
AD6	2	2.0	2	3.0	2	2.5	2	3.6	2	3.8	3.0	2.8
AD7	1	2.0	1	3.0	1	4.0	1	3.0	2	3.2	3.1	2.8
AD8			1	4.0	2	2.6	1	3.0	2	6.2	4.1	3.0
AD9							2	3.7			3.7	4.0
AD10							1	7.5			7.5	4.0
AD11									1	6.0	6.0	4.0
AD12												6.7
AD13												6.7
AST1												3.0
AST2												3.0
AST3			1	2.0	1	9.5					5.8	3.0
AST4									1	3.0	3.0	3.0
AST5												4.0
AST6	1	3.0									3.0	4.0
AST7												4.0
AST8			1	4.0							4.0	4.0
AST9												n/a
AST10												5.0
AST/SC1												4.0
AST/SC2												5.0
AST/SC3												5.9
AST/SC4												6.7
AST/SC5												8.3
TOTAL	5		6		6		7		8			

Table 22: Reclassification of temporary staff/promotion of officials

3.5.1.2.2 Reclassification of contract staff

Function group	Grade	No of staff in activity on 1 January 2020 (year .01.N – 2 (2020)	No of staff reclassified in 2021 (year N *n* – 1 (2021)	Average number of years in grade of reclassified staff members	Average number of years in grade of reclassified staff members (according to Decision C(2015) 9561)
CA IV	17	–	–	–	6–10
	16	1	–	–	5–7
	15	–	–	–	4–6
	14		–	–	3–5
	13	1	–	–	3–5
CA III	11	–	–	–	6–10
	10	–	–	–	5–7
	9	–	–	–	4–6
	8	–	–	–	3–5
CA II	6	–	–	–	6–10
	5	–	–	–	5–7
	4	–	–	–	3–5
	3	–	–	–	6–10
CA I	2	–	–	–	3–5
	1	–	–	–	6–10

Table 23: Reclassification of contract staff

No contract staff members were reclassified during 2020 or 2021.

3.5.1.3 *Mobility policy (internal mobility, between EU bodies and between EU bodies and the institutions)*

3.5.1.3.1 Mobility within the SESAR 3 Joint Undertaking

Vacancy notices are accessible internally as well as externally, and staff members are always given the opportunity to apply.

3.5.1.3.2 Mobility between EU bodies

Until 2016, the SESAR 3 JU's statutory staff were excluded from the possibility of benefiting from mobility between the EU agencies, substantially limiting one of the key elements of the career development of its staff. This situation has changed with the adoption of new implementing rules on the selection of those for TA 2(f) positions in April 2016 under the new staff regulations.

3.5.1.3.3 Mobility between the SESAR 3 Joint Undertaking and the institutions

The SESAR 3 JU currently has no posts occupied by an official from an institution ([15]); nevertheless, where appropriate, the SESAR 3 JU can consider favouring mobility with the institutions.

([15]) There is one TA who is on secondment from the European Commission in its own interest.

3.5.1.4 *Gender representation*

Since its establishment, the SESAR 3 JU has ensured equal opportunities for staff and has done its best to attract specialised technical staff of the highest calibre. The equal opportunities policy is applied to recruitments in order to secure a gender balance and a geographical balance in a domain of operations that appears to be highly unbalanced.

Gender	Function group	Officials		TAs		CAs		Total	
		No of staff	%	No of staff	%	No of staff	%	No of staff	%
Female	AD/FG IV			15		1		16	46
	AST and AST/SC			4				4	11
	Total			19		1		20	57
Male	AD			13				13	37
	AST and AST/SC			2				2	6
	Total			15				15	43
Overall total				**34**	**97**	**1**	**3**	**35**	**100**

Table 24: Gender representation of statutory staff (officials, TAs and CAs) as at 31.12.2021

Gender	2017 (year N – 5)		2021 (year N – 1)	
	No of staff	%	No of staff	%
Female managers	0	0	0	0
Male managers	2	100	3	100
Total	**2**	**100**	**3**	**100**

Table 25: Gender evolution of middle and senior management over 5 years

3.5.1.5 *Geographical balance*

Nationality	AD and CA FG IV		AST/SC, AST, CA FG I–-III		Total	
	No of staff	% of total AD and CA FG IV staff	No of staff	% of total AST/SC, AST, CA FG I–III staff	No of staff	% of total staff
Belgium	3	10	2	33	5	14
Bulgaria	1	3	1	17	2	6
Cyprus	0	0	1	17	1	3
Germany	1	3	0	0	1	3
Greece	2	7	0	0	2	6
France	5	17	1	17	6	17
Ireland	2	7	0	0	2	6
Italy	4	14	1	17	5	14

Lithuania	1	3	0	0	1	3
Netherlands	2	7	0	0	2	6
Portugal	1	3	0	0	1	3
Spain	4	14	0	0	4	11
United Kingdom	3	10	0	0	3	9
Total	**29**	**100**	**6**	**100**	**35**	**100**

Table 26: Geographical representation of statutory staff (officials, TAs and CAs) as at 31 December 2021

Most represented nationality	2017 (year N – 5)		2021 (year N – 1)	
	Number	%	Number	%
United Kingdom	7/38	18	3/35	9

Table 27: Evolution of the most-represented nationality in the SESAR 3 JU over 5 years

3.5.1.6 *Schooling*

The European Schools in Brussels should cover the schooling needs of children of SESAR 3 JU staff, for those members of staff currently eligible.

Agreement in place with the European School(s)	
Contribution agreements signed with the European Commission on type I European Schools (yes/no)	No. SESAR staff with a contract with a minimum duration of 1 year and who receive family allowances from the SESAR 3 JU can have their children enrolled in the European Schools (type I) in Brussels as category I pupils, meaning that they are accepted as a priority and no school fees have to be paid by the parents. A contribution agreement was not concluded at that time owing to the low number of children of SESAR 3 JU staff in the European Schools
Contribution agreements signed with the European Commission on type II European Schools (yes/no)	No
Number of service contracts in place with international schools	0
Description of any other solutions or actions in place	n/a

Table 28: Schooling arrangements implemented by the SESAR 3 JU

3.5.2 Staff establishment plan

Function group and grade	2021				2022		2023	
	Authorised budget		Actually filled as of 31 December 2021		Envisaged		Envisaged (to be confirmed)	
	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts	Permanent posts	Temporary posts
AD16								
AD15		1				1		
AD14								1
AD13		1				2		2
AD12		4		4		3		3
AD11		3		1		4		5
AD10		2		2		2		2
AD9		6		6		7		8
AD8		7		6		7		7
AD7		4		6		4		3
AD6		3		3		1		
AD5								
Total AD		31		28		31		31
AST11								
AST10								
AST9		1		1		1		1
AST8								
AST7		1				1		1
AST6								
AST5		2		1		3		3
AST4		1		2				1
AST3		1		1		1		
AST2				1				
AST1								
Total AST		6		6		6		6
AST/SC6								
AST/SC5								
AST/SC4								
AST/SC3								
AST/SC2								
AST/SC1								
Total AST/SC		0		0		0		0
Overall total		37		34		37		37

Table 29: Multiannual staff policy plan for years 2021–2023

Function group	2021			2022	2023
	FTE corresponding to authorised budget	Executed FTE as of 31 December 2021	Headcount as of 31 December 2021	FTE corresponding to authorised budget	FTE corresponding to authorised budget
IV	1	1	1	1	1
III					
II					
I					
Total	**1**	**1**	**1**	**1**	**1**

Table 30: Evolution of CAs per function group over the 2021–2023 period

Seconded national experts	2021			2022	2023
	FTE corresponding to authorised budget	Executed FTE as of 31 December 2021	Headcount as of 31 December 2021	FTE corresponding to authorised budget	FTE corresponding to authorised budget
Total	2	1.75	2	2	2

Table 31: Evolution of SNEs over the 2021–2023 period

Job title in the SESAR JU	Type of contract (official, CA, TA)		TA/official		CA
			Function group/grade of recruitment internal and external (single grade) foreseen for publication		Recruitment function group (I, II, III and IV)
	Due to foreseen retirement/mobility	New post requested due to additional tasks	Internal	External	
Executive Director	TA		n/a	AD14	
Grant manager	TA		AD5–AD7	AD6	
Financial officer	TA		AD5–AD7	AD6	
Programme officer	TA		AD6–AD8	AD7	
Head of quality, planning and reporting	TA		AD7–AD9	AD8	

Table 32: Recruitment forecasts for 2022 and 2023 following retirement/mobility or new requested posts

3.6 Efficiency gains

The SESAR 3 JU will implement a strategy to secure efficiency gains.

It will benefit from the following efficiency measures and synergies that were already implemented in the context of the SESAR 3 JU from 2008 to 2021, which will be continued.

- **Collaboration with EUROCONTROL.** In application of Article 158 the SESAR 3 JU will seek the maximum synergies with EUROCONTROL regarding the services that the latter can make available. For other services, the SESAR 3 JU will reflect on possibilities to find back office arrangements with the other JUs where possible.
- **Collaboration with the European Commission.** The SESAR 3 JU will leverage synergies from the use of the European Commission's ICT systems and services (such as contracts with ICT service providers and suppliers). The ICT systems supplied by the Commission are in particular related to:
    - financial management and accounting systems (attribute-based access control (ABAC));
    - human resources management (SYSPER job information system modules, DOC Engine);
    - the management of Horizon Europe calls for proposals and grants;
    - procurement (e-procurement);
    - document management, namely the use of the European Commission's advanced records system (ARES), a document management system.
- **Quality management.** The SESAR 3 JU undertakes regular process improvement initiatives in the context of the quality management system (QMS) supervised by the QICT Committee in order to monitor the effectiveness and efficiency of business processes and IT tools, and to focus on value added activities.
- **Information and document management.** The QICT Committee also supervises the implementation and continuous improvement of the SESAR JU's information and document management system (IDMS), which aims to simplify and streamline the management of information and documentation within the organisation. The IDMS is based on software implemented in 2017 and has been under constant improvement since then. The implementation of modules in ARES will also streamline communication with Commission services.
- **Electronic workflows.** The managed configuration of electronic systems supporting quality and information processes and key workflows that can be operated either locally or remotely makes teleworking measures possible, with limited impact on the SESAR 3 JU's business continuity. This is thanks to the effectiveness of the SESAR 3 JU's ICT system, which includes collaboration platforms and electronic workflows that, in combination with ABAC workflows, support the most critical processes bound with strict deadlines.
- **Staff mission management.** Owing to the increased use of video conferences, the number of missions has been reduced, especially for recurring monitoring activities such as project reviews. This represents a significant benefit in terms of environmental footprint, efficiency and work–life balance.

The SESAR 3 JU will develop close cooperation and ensure coordination with other European partnerships, where appropriate, through joint calls. For example, in 2022, the SESAR 3 JU will participate, together with the other joint undertakings under Horizon Europe, in a study to explore possible efficiency gains in a back-office arrangement approach.

Furthermore, in accordance with Article 165 of the financial regulation ([16]), whenever there is a possibility for realising efficiency gains, the SESAR 3 JU and other EU institutions and bodies concerned may carry out the procedure and the management of the subsequent contract or framework contract on an interinstitutional basis under the lead of one of these contracting authorities.

([16]) 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, OJ L 193, 30.7.2018, p. 1.

4 Governance

4.1 Objectives, activities, indicators and targets

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Ensure effective and efficient governance of the programmes implemented by the SESAR 3 JU	Organisation of meetings of the Governing Board	Number of meetings of the Governing Board	at least 2 per year([17])	at least 2 per year
		Organisation of meetings of the scientific advisory body	Number of meetings of the scientific advisory body (Scientific Committee)	2 per year ([18])	2 per year
		Organisation of meetings of the States' Representatives Group	Number of meetings of the States' Representatives Group	2 per year ([19])	2 per year
SESAR 2020	Ensure effective and efficient supervision and closure of the SESAR 2020 programme	Organisation of meetings of the SESAR 2020 Programme Committee and Delivery Management Subcommittee (DMSC)	Number of meetings of the SESAR 2020 Programme Committee and DMSC	4 per year each	2per year each
Digital European Sky programme	Ensure effective and efficient supervision of the **Digital European** Sky programme	Establishment of the SESAR 3 Programme Committee and DMSC	Percentage of requested members appointed	100 %	n/a
		Organisation of the meetings of the SESAR 3 Programme Committee and DMSC	Number of meetings of the SESAR 3 Programme Committee and DMSC	3 per year each	4 per year each

Table 33: Objectives, activities, indicators and targets for governance related issues in 2022 and 2023

([17]) Article 16(5) of the Single Basic Act
([18]) Article 21(6) of the Single Basic Act.
([19]) Article 20(3) of the Single Basic Act.

4.2 SESAR 3 Joint Undertaking governing bodies

With reference to the basic act of the SESAR 3 JU, the governance is depicted in Figure 7.

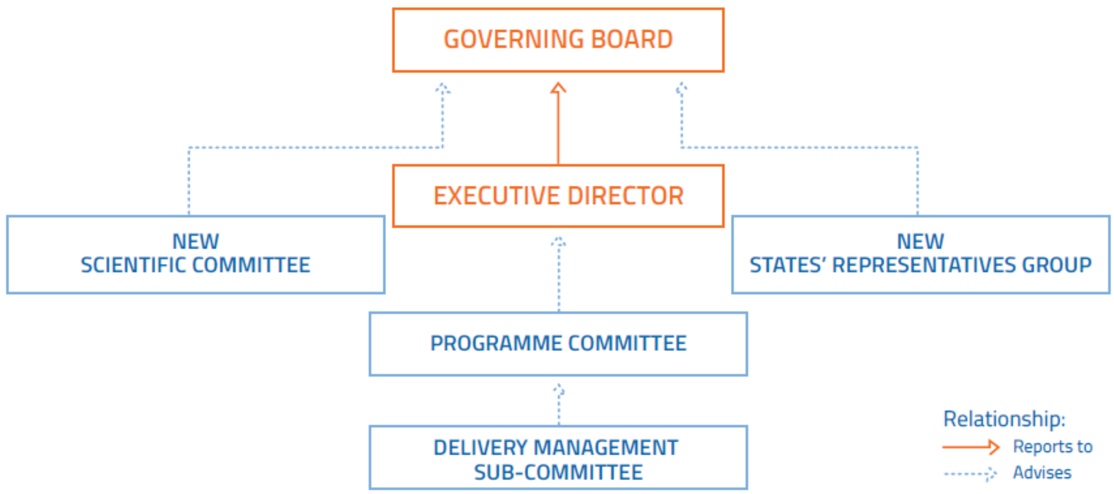

Figure 7: SESAR 3 JU governance

4.2.1 Governing Board

The composition, functioning and tasks of the SESAR 3 JU are outlined in Section 3.1.1 of the MAWP.

Under the supervision of the Executive Director, in Q1 2022 the SESAR 3 JU will complete the setting up of the Governing Board, which began in November 2021. Throughout 2022, it will provide secretariat support, assisting new members and organising the Governing Board meetings and written procedures necessary to the functioning of the decision-making process.

During the period of reference, the Governing Board will also ensure the oversight of the successful implementation of the action plan for simplification and strengthening of the Master Plan process.

Table 34 provides a provisional timetable for key Governing Board activities and decisions in 2022 and 2023.

Q1 2022	Adopt a decision on the Internal Audit Capability's work plan for 2022 Adopt the first BAWP (for 2022–2023)
Q2 2022	Adopt the *Consolidated Annual Activity Report 2021* and the decision on its assessment Adopt the membership agreement Adopt the SESAR 3 JU–EUROCONTROL agreement Appoint the SESAR 3 Executive Director Adopt the SESAR 3 JU communication policy/strategy
Q3 2022	

Q4 2022	Deliver an opinion on the SESAR 3 JU's final accounts
Q1 2023	
Q2 2023	Adopt the *Consolidated Annual Activity Report 2022* and the decision on its assessment
Q3 2023	
Q4 2023	Adopt a plan for the phasing out of the SESAR 3 JU from Horizon Europe funding

Table 34: Provisional timetable for key Governing Board activities and decisions in 2022 and 2023

4.2.2 Executive Director

The functions of the Executive Director are outlined in Section 3.1.2 of the MAWP.

4.2.2.1 *SESAR 3 Joint Undertaking Programme Committee*

The role of the SESAR 3 JU Programme Committee is described in Section 3.1.2.1 of the MAWP. In accordance with the MAWP, this committee will be established in the course of 2022 and will operate for the duration of the Digital European Sky programme. The SESAR 3 JU Programme Committee may establish subcommittees to work on detailed tasks.

4.3 Advisory bodies

4.3.1 States' Representatives Group

The role of the States' Representatives Group is described in Section 3.1.3.1 of the MAWP. This group will be established in the course of 2022 with the objective to hold two meetings per year. Additional information on the activities to be carried out by the States' Representatives Group will be made available in the amended work programme.

4.3.2 Scientific Committee

The role of the Scientific Committee is described in Section 3.1.3.1 of the MAWP. This committee will be established in the course of 2022. Additional information on the activities to be carried out by the Scientific Committee will be made available in the amended work programme.

5 Strategy and plans for the organisational management and internal control systems

5.1 Objectives, activities, indicators and targets

	Objectives	Activities	Indicators	Target for 2022	Target for 2023
SESAR 3 JU	Monitor the efficiency and effectiveness of the SESAR 3 JU's corporate and management activities	TBD	Level of compliance with the internal control framework during 2022 and 2023	100 %	100 %
		TBD	• Discrepancies against processes, and their translation into QMS improvement actions • Continuous registration of improvement actions as part of the SESAR 3 JU's QMS	All process improvement actions taken in accordance with the defined action plan, if discrepancies are found	All process improvement actions taken in accordance with the defined action plan, if discrepancies are found
		TBD	Level of corporate risks as per the risk management plan, allowing for the leveraging of opportunities	The level of corporate risks is acceptable and all risk-related actions are implemented in accordance with the mitigation plan	The level of corporate risks is acceptable and all risk-related actions are implemented in accordance with the mitigation plan
	Monitor the efficiency and effectiveness of budget and finance activities	Preparation of the budget-related documentation in line with the Commission standards and requirements	Budget request for 2023 and 2024 submitted in a timely manner to the European Commission	100 % (for 2023)	100 % (budget request for 2024)
		Accurate execution and monitoring of the budget	Percentage of SESAR 2020 and Digital European Sky balancing payments executed in a timely manner	100 % of requested payments made	100 % of requested payments made

Objectives	Activities	Indicators	Target for 2022	Target for 2023
	Supervision of levels of commitment and payment appropriations	Budget execution: commitment and payment appropriations are executed as planned in the 2022 and 2023 budget	90 % for commitment appropriations 85 % for payment appropriations	90 % for commitment appropriations 85 % for payment appropriations
	• Analysis and correction of the accounts • Preparation of the necessary documentation in line with Commission standards and requirements	Completion of 2021 and 2022 annual accounts within regulatory deadlines	100 % (for 2021 annual accounts)	100 % (for 2022 annual accounts)
	Support for the European Court of Auditors' audit and provision of relevant documentation leading to an unqualified opinion on the 2021 and 2022 accounts	European Court of Auditors' opinion on the 2021 and 2022 accounts	Unqualified opinion (for 2021 annual accounts)	Unqualified opinion (for 2022 annual accounts)
Monitor the efficiency and effectiveness of project audit activities	• Quarterly follow-up of the status of the audits (open/scheduled/finalised) • Participation in meetings of the Research & Innovation Audit Network (RIAN) where the status of all audits is presented by the Common Audit Service of the Directorate-General for Research and Innovation (CAS) • Organise meetings with the CAS to discuss particular issues/delays	Horizon 2020 project audits: provision of necessary inputs to the CAS to execute audits	100 % (in 2021)	100 % (in 2022)

Objectives	Activities	Indicators	Target for 2022	Target for 2023
Monitor the exception and non-compliance events register	Register the exceptions and non-compliance events per SESAR 3 JU area	Percentage of exceptions and events that are identified and notified	100 %	100 %

Table 35: Objectives, activities, indicators and targets for internal control framework in 2022 and 2023

5.2 SESAR 3 Joint Undertaking's quality management system (QMS)

The SESAR 3 JU implements the Commission's internal control framework through its QMS, which has been in place since 2015 ([20]) and is accessed via a portal on the SESAR 3 JU's IT system. The QMS is implemented to help the SESAR 3 JU to achieve its objectives and optimise its value to stakeholders. The SESAR 3 JU's quality manual describes the approach, which is represented in Figure 8.

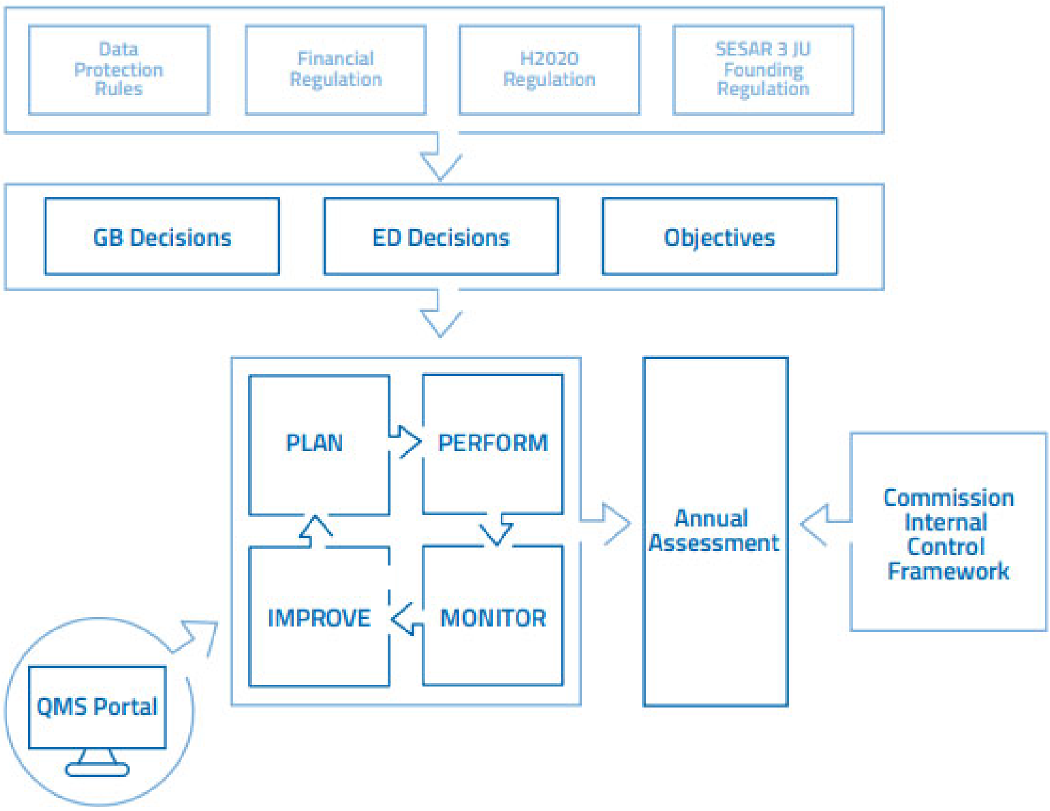

Figure 8: The SESAR 3 JU implementation of the internal control framework

The suitability and effectiveness of the achievement of the SESAR 3 JU objectives (including the performance of the QMS) is assessed annually and is reported using relevant indicators for all internal control principles and related characteristics in the consolidated annual activity report.

The SESAR 3 JU quality manual includes a defined strategy to deploy a QMS and applies continual improvement through a 'plan, do, check and act or improve' (PDCA) cycle. This continual improvement cycle applies to all of the processes used at the SESAR 3 JU to comply with its obligations and to deliver its expected results. It also involves the tools related to these processes, and the people who use these tools and processes. The SESAR 3 JU application of the PDCA cycle is summarised below.

Plan. The BAWP is the primary planning tool for the SESAR 3 JU and is complemented by lower level objective-setting established by the Executive Director with the corporate management team.

([20]) The quality management approach at the SESAR 3 JU has been defined and adopted through SJU/ED/395.

Do. The SESAR 3 JU meets its objectives through the execution of its processes and the suitability of these processes to the objectives. Ensuring the stability of the processes and their alignment with the strategic goals and objectives is key to the SESAR JU's performance and to ensuring that stakeholder requirements can be met, which will in turn help build stakeholder confidence.

Roles and responsibilities with regard to process management are established. Process definitions together with a comprehensive process map are published through the QMS portal. By monitoring adherence to these processes, the QMS helps the SESAR JU to achieve these results.

Check. Several structures have been put in place, either by a regulation or by a decision of the Executive Director, to monitor the SESAR 3 JU's activities. These structures benefit from input from the QMS regarding the adherence of the SESAR 3 JU to its processes, and the adequacy of such processes. These structures include:

- the Governing Board;
- the corporate management team;
- the Budget Control Committee;
- the QICT;
- the project audit;
- the Internal Audit Capability;
- annual reporting through the consolidated annual activity report.

Act (improve). As a result of monitoring activities, the SESAR 3 JU routinely initiates change and improvement initiatives.

5.2.1 Annual assessment

In continuity with 2021, in 2022 and 2023, the SESAR 3 JU will carry out corporate management team annual reviews to assess and monitor the performance of the SESAR JU by assessing each of the relevant indicators for all internal control principles and related characteristics.

The consolidated annual activity reports will report on these indicators.

5.3 Financial management

The SESAR 3 JU will continue to work with a proactive approach to ensure the transparent and effective management of financial resources and a high level of budget implementation (in terms of both commitments and payments).

During 2022 and 2023, the SESAR 3 JU will continue to streamline workflows within the SESAR 3 JU's finance-related IT systems (ABAC by SAP and the SESAR 3 JU's own IDMS, complemented with Speedwell for some financial transactions) and with regard to the Horizon 2020 IT tools (SYGMA/COMPASS), and to maintain a high level of accuracy in budgetary forecasting.

The procedures and tools at the SESAR 3 JU related to services contracted to the European Commission's Directorate-General for Budget will continue to be implemented in accordance with the service agreements. These services are treasury services, accounting, the central budgetary framework, recovery actions, the validation of local systems and financial reporting.

5.3.1 Financial monitoring and control

In 2022 and 2023, the SESAR 3 JU will ensure the reliability and completeness of the financial information necessary for the budgetary execution. The SESAR JU's budget implementation financial procedures, circuits and controls will be monitored through diverse axes certifying adequate and efficient documentation with appropriate scrutiny and quality control of the implemented budget.

This will require:

- evaluation of the financial processes and circuits in the finance and budget field, with adaptation to the new financial rules when necessary;
- an analysis of *ex ante* control in terms of risk and efficiency;
- reviews of the accessibility and correctness of reports;
- deployment and documentation through dashboards;
- ensuring the accuracy of ABAC workflow users and access rights;
- arrangements for new financial e-tools to be deployed or upgraded.

5.4 Internal control, risk management and audits

5.4.1 *Ex ante* controls

Ex ante controls remain important tools to help the SESAR 3 JU prevent errors and to avoid the need for *ex post* corrective actions. In accordance with Article 74 of the EU financial regulation and Article 21 of the SESAR 3 JU's financial rules, 'each operation shall be subject at least to an *ex ante* control relating to the operational and financial aspects of the operation, on the basis of a multiannual control strategy which takes risk into account'. The main objective of *ex ante* controls, therefore, is to ensure that the principle of sound financial management is applied. In 2022 and 2023, the following *ex ante* activities will take place:

- generating and checking grant agreements;
- initiating, checking and verifying invoices for administrative expenditure;
- assessing periodic reports from grants and verifying and paying cost claims.

5.4.2 *Ex post* controls

One of the other major pillars of assurance for the SESAR 3 JU is its *ex post* audit activity. Its main objectives are as follows:

- providing the authorising officer with the necessary elements of assurance on the operational expenditure in a timely manner;
- assessing the regularity and legality of the transactions;
- attaining residual error rates at an acceptable level at the closure of the SESAR 2020 programme, once the financial impact of all audits and correction and recovery measures has been taken into account;
- determining the sound financial management of the transactions, with the support of the internal or external technical experts, with the overall objective being to assess the value for money of the SESAR 3 JU's operations;

- identifying systemic errors through the analysis and synthesis of the results obtained and formulating recommendations to address the issues;
- providing the SESAR 3 JU auditees with recommendations to improve the financial management, processes, procedures and practices applied to the activities related to the SESAR 3 JU's contracts, with the main purpose being to ensure that recurring errors are avoided by the SESAR 3 JU beneficiaries.

In 2022, the audit activity is expected to encompass (according to the Horizon 2020 audit strategy) audits in 15 participations performed by CAS, as well as the follow-up and closure of any pending audits previously launched, regular meetings and the exchange of information. For all of these activities, the SESAR 3 JU actively participates in the CAS coordination mechanisms.

In 2023, the audit activity will encompass audits in another 15 participations to be performed by CAS.

The SESAR 3 JU will also contribute to the implementation strategy for Horizon Europe, in particular by participating in discussions and making proposals for a common audit approach on common financial rules.

The enhanced communication campaign provided by CAS will support external stakeholders when needed.

5.4.3 Corporate risk management

The SESAR 3 JU risk management policy addresses up to five threads of risks: corporate risks, master plan risks, SESAR 3 JU internal risks, SESAR 2020 programme risks and Digital European Sky programme risks. The policy focuses on the management of critical risks, defined as risks that:

- endanger the realisation of objectives outlined in the European ATM Master Plan;
- cause serious damage to the SESAR partners (SESAR 3 JU members and the broader stakeholder community involved in the execution of the European ATM Master Plan);
- result in critical intervention at the political level (the European Parliament, Council of the European Union and European Commission) regarding the SESAR 3 JU's performance;
- result in the infringement of laws and regulations;
- result in the misuse of public money;
- put the safety levels of aviation at stake;
- in any way have a serious impact on the SESAR 3 JU's image and reputation.

The list of critical risks that may affect the achievement of the SESAR 3 JU's objectives for 2022 and 2023 as per the above definition, extracted from the SESAR 3 JU's corporate risk register, appears in Section 6 of Chapter II.

5.4.4 Strategic risk assessment

In November 2018, the Internal Audit Service (IAS) conducted a strategic risk assessment of the SESAR 3 JU. This entailed the IAS analysing all of the operational, administrative, financial and IT processes of the SESAR 3 JU, with the aim of identifying areas of risk and future audit topics. This strategic risk assessment was performed in coordination with the SESAR 3 JU Internal Audit Capability, and led to the 2019–2021 strategic internal audit plan, which was published in May 2019.

The next in-depth risk assessment by the IAS is planned for 2022 and a subsequent strategic audit plan for 2023–2025 is expected.

5.4.5 Anti-fraud strategy

Taking into account the screening of the fraud risks and the tools at the SESAR 3 JU's disposal, the SESAR 3 JU has decided to concentrate its efforts on achieving three strategic objectives. SESAR 3 JU staff, members of SESAR 3 JU committees, scientific experts and members of the governance bodies the Governing Board, the States' Representatives Group and the Scientific Committee must support these objectives and pursue the highest standards of honesty and integrity in the exercise of their duty. Section 6 of this chapter details the actions that will be taken by the SESAR 3 JU to reach these objectives.

5.4.5.1 *Objective 1: Maintain a culture of integrity*

Integrity and high standards of professional conduct are crucial for the independence and reputation of the SESAR 3 JU. By their nature, in joint undertakings, public and private interests are mixed and there is a likelihood of conflicts of interest, which, in the case of the previous period of operation of the SESAR 3 JU, was successfully managed over the duration of two programmes. The SESAR 3 JU's objective for this anti-fraud strategy is to continue to promote and maintain the highest level of ethical behaviour among staff in relation to the wider SESAR 3 JU community. This starts with an appropriate tone at the top, cultivating an organisational culture that does not tolerate fraud, malfeasance or other forms of corruption, and will include looking at lessons learned.

5.4.5.2 *Objective 2: Build capacities through training and guidance*

To ensure that managers and staff members are aware of their responsibilities regarding preventing fraud, awareness building is of key importance. Additionally, training is vital in maintaining the effectiveness and credibility of the strategy. Therefore, the SESAR 3 JU will focus on training and other awareness-raising actions on both ethics and fraud prevention and detection. Each staff member should be made aware of types of ethical behaviour that must be observed. In parallel, the SESAR 3 JU will update the existing anti-fraud guidelines to include the latest developments of the European Commission, and the templates used by the SESAR 3 JU to declare conflicts of interest will be updated. The SESAR 3 JU will ensure easy access to this information via an intranet page dedicated to anti-fraud and ethics.

5.4.5.3 *Objective 3: Prevent and detect external fraud*

The SESAR 3 JU has established *ex ante* and *ex post* controls for expenditures. Staff in operational and financial units are the best-placed persons to detect external fraud in the area of programme and project management. For financial staff, the objective of this strategy is to avoid double funding and ensure a strong focus on fraud detection. On the operational side, the SESAR 3 JU aims to sensitise beneficiaries to the most common errors and anti-fraud-related measures that the Commission is undertaking.

Regarding Horizon 2020 and Horizon Europe grant implementation, the anti-fraud action plan for the research family for 2019 (adopted by the Common Implementation Centre Executive Committee on 21 March 2019) develops additional anti-fraud provisions in the model grant agreement, IT systems and business processes (notably, a specific tool to detect double funding detection and plagiarism is being set up). Therefore, an important element of this strategy is to stay abreast of the additional tools, processes and lessons learnt in the context of the anti-fraud action plan for the research family for 2019 and inform SESAR 3 JU staff accordingly.

The SESAR 3 JU plans to update its anti-fraud risk strategy during the period of reference of this work programme.

5.4.6 Audits

5.4.6.1 *Internal Audit Capability*

The SESAR 3 JU's Internal Audit Capability will perform audits and consulting engagements based on risks identified in 2021 and 2022. It will also coordinate activities with the IAS and the European Court of Auditors as described below. The 2023 annual audit plan of the Internal Audit Capability will be presented to the Governing Board in December 2022.

5.4.6.2 *Internal Audit Service*

Internal audits are carried out by the Internal Audit Service (IAS) in liaison with the Internal Audit Capability

In 2022, the IAS will conduct a Strategic Risk Assessment of the SESAR 3 JU. This entails that the IAS will analyse all operational, administrative, financial and IT processes of the SESAR 3 JU with the aim of identifying areas of risk and future audit topics. This Strategic Risk Assessment will lead to the next IAS the Strategic Internal Audit Plan, which will include the future audit topics for 2023 up to 2025.

Information about the internal audits to be carried out by the IAS in 2023 will be made available in the future amendments of the Bi-Annual Work Programme.

5.4.6.3 *European Court of Auditors*

At this stage, the SESAR 3 JU is not aware of any external audits to be conducted by the European Court of Auditors in 2022 or 2023, with the exception of the recurring annual audit of the accounts.

Information about the external audits to be carried out by the ECA in 2023 will be made available in the future amendments of the Bi-Annual Work Programme.

6 SESAR 3 Joint Undertaking's critical risks

Table 36 presents a summary of the most significant risks to be noted for the SESAR 3 JU and its activities. The risks were defined and maintained through the risk assessment exercise performed by the SESAR JU's management. Additional information on the SESAR 3 JU's risks will be made available in the amended work programme.

Risk reference	Description of risk	Affected objective(s) [21]	Criticality	Summary of risk mitigation
CORP08	The COVID-19 crisis brings different types of challenges to the SESAR 3 JU relating to: - the members' ability to support the established programme delivery due to the financial/resource situation of the aviation sector: • the technical contributions of one or several members to the SESAR 2020 programme may be lower than provided for in the membership agreement; • this situation would have an impact on the outcome of the SESAR 2020 projects, the delivery of SESAR solutions and progress in achieving the master plan; - impacts on the internal functioning of the SESAR 3 JU: restrictions issued by the Belgian authorities and/or the European Commission on travel, access to the office and mandatory telework can lead to inefficiencies, misunderstandings and errors being made, as well as psychological impacts on staff.	- Monitor the efficiency and effectiveness of budget and finance activities (Section 5.1) - Execute the validation exercises of release 12 (Section 2.2.3.3) - Supervise and close IR-VLD wave 3 projects (under call for proposals H2020-SESAR-2020-2) (Section 2.2.3.3)	Moderate	• Undertake an impact analysis and implement adaptations to prioritise the SESAR programme delivery plans as required • Optimise the use of available funds through the transfer of the unused budget between calls • Establish support contracts with aviation stakeholders • Adapt the terms of payments for 2020 and 2021 to reduce the cash pressure on SESAR 3 JU members and beneficiaries (cash to be recovered in future years in accordance with the actual in-kind contributions to operational activities (IKOP)) • Increase pre-financing • Revise/optimise the SESAR 3 JU's running costs budget • Closely monitor and forecast the IKOP to enable accurate forecasting of the expected running cost contributions. If required, staff reduction and/or termination of contracts with service providers would be envisaged • Undertake ICT testing for full-scale telework arrangements • Trigger business continuity and establish a crisis management cell to prepare strategies and plans • Undertake a regular staff survey to monitor how staff adapt to the new working measures • Monitor the ICT infrastructure that supports the general teleworking arrangements, including mixed

[21] This column identifies which objectives may be affected by the risk, should it occur, with reference to the objectives identified in the relevant sections of this chapter (2.2, 3.1, 4.1 and 5.1).

Risk reference	Description of risk	Affected objective(s) ([21])	Criticality	Summary of risk mitigation
				teleworking and working from premises modes • Acquire new IT tools, formalise new contracts and/or agreements with the Commission, and implement revised procedures supported by digital solutions (e.g. electronic workflows) to cope with the authorisation of legal and financial transactions • Maintain a return-to-office strategy to provide clear guidance to staff about maintaining a safe working environment • Organise coaching sessions for the staff to adapt to the teleworking measures • Maintain a reserve in the SESAR 3 JU budget • Monitor the effective contribution of non-EU members
CORP12	A letter has been received by the SESAR 3 JU announcing the withdrawal of the Directorate-General for Budget's accounting shared service from October 2022. Given the lack of available and skilled resource, this action puts at risk the continuity and ongoing quality of the accounting function	Monitor the efficiency and effectiveness of budget and finance activities (Section 5.1) – as the withdrawal of accounting services by the Directorate-General for Budget could lead to a reduced quality of accounting	High	Cooperate with other affected joint undertakings to find a common solution for all, for instance by operating a specific back office arrangement with other joint undertakings in this field.

Table 36: SESAR 3 JU critical risks and related mitigation actions

Chapter III – Budget

1 Revenue

Statement of revenue					
Title/chapter	Heading	Financial year 2022 (Final budget)		Financial year 2023 (1st Amending budget 2023)	
		Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations
EU contribution (excluding European Free Trade Association (EFTA) and third countries' contribution) ([22])	1	**128 030 927**	**136 916 728**	**86 511 174**	**88 246 348**
of which (fresh C1) administrative (Titles 1 and 2)				3 545 534	3 545 534
of which frontloaded commitments (Titles 1 and 2)	**1.1**		3 244 911	0	3 572 618
of which operational (Title 3 & 4)	**1.1**	86 280 927	111 921 817	82 965 640	81 128 196
Of which C2 Operational (Title 4)		40 000 000	20 000 000		
of which related to additional entrusted tasks		1 750 000	1 750 000		
EFTA and non-EU countries' contribution	1.1	**2 131 139**	**2 652 962**		**2 478 276**

([22]) This information has to be obtained by the joint undertakings from the parent Directorates-General when they work on the work programme or its update, as joint undertakings do not have an overview of the different fund sources that are included in the EU contribution. Even though the joint undertakings normally have an entry for the 'overall Union contribution received' (including EFTA and non-EU countries' contribution) under the contribution agreements, a breakdown of the EU contribution per fund source would allow the Commission financial services to cross-check it with the data already provided (from hearings, WD III and ABAC).

of which administrative EFTA (Titles 1 and 2)	**1.1**		68 468	102 466	189 995
of which administrative third countries excluding EFTA (Titles 1 and 2)	**1.1**				
of which operational EFTA (Title 3 and 4)	**1.1**	2 131 139	2 584 494	2 397 707	2 288 281[23]
of which operational third countries excluding EFTA (Title 3)	**1.1**				
Financial contribution from members other than the EU contribution	**2.1; 3.1**	**5 658 552**	**4 838 936**	**4 226 325**	**5 044 663**
of which administrative (Titles 1 and 2)		5 658 552	4 838 936	4 226 325	5 044 663
of which operational (Title 3)					
Financial contributing partners' contribution					
Interest generated					
Unused appropriations from previous years	**5.1**	**22 965 846**	**2 463 259**	**5 160 147**	**126 090 800**
of which administrative		19 265 846	2 463 259	5 160 147	1 500 000
of which operational		3 700 000			124 590 800
Total estimated revenue		**158 786 464**	**146 871 885**	**98 397 819**	**221 860 086**

([23]) There is 1-euro difference due to rounding. The actual EFTA contribution to be received is EUR 2 288 280.

Table 37: Final SESAR 3 JU revenue 2022 and initial SESAR 3 JU revenue 2023 – commitment & payment appropriations

SESAR 2020 JU in-kind revenue over the 2021-2024 period (N to N+3)

(EUR)

TITLE/CHAPTER	Revenue entitlements estimated by the agency			
	N (2021)	N+1 (2022)	N+2 (2023)	N+3 (2024)
1. In-kind contribution from founding members	**60.579.895**	**49.882.346**	**60.428.898**	**60.335.476**
1.1 European Union	-	-	-	-
1.2 EUROCONTROL	*60.579.895*	*49.882.346*	*60.428.898*	*60.335.476*
2. In-kind contribution from other members	**45.974.388**	**31.269.511**	**39.572.124**	**48.841.330**
2.1 Other members	*45.974.388*	*31.269.511*	*39.572.124*	*48.841.330*
TOTAL in-kind revenue	**106.554.283**	**81.151.857**	**100.001.022**	**109.176.805**

Table 38: Latest in-kind revenue budget over the 2021–2024 period (N-1 to N+3)

2 Expenditure

STATEMENT OF EXPENDITURE					
Title Chapter	**Heading**	**Financial year 2022 (Final budget)**		**Financial year 2023 (1st Amending budget 2023)**	
		Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations
1. Staff					
Salaries and allowances	**11**	**5 323 760**	**5 128 860**	**5 874 942**	**6 353 905**
of which establishment plan posts		4 800 000	4 700 000	5 250 000	5 643 690
of which external personnel		523 760	428 860	624 942	710 215
Expenditure relating to staff recruitment	**12**	**5 000**	**5 000**	**6 600**	**7 203**
Mission expenses	**13**	**200 000**	**200 000**	**230 000**	**287 740**
Socio-medical infrastructure	**14**				
Training	**15**	**40 000**	**40 000**	**48 812**	**48 812**
External services	**16**	**90 000**	**90 000**	**82 250**	**84 250**

Receptions, events and representation	**17**				
Social welfare	**18**				
Other staff-related expenditure	**19**	**50 000**	**50 000**	**53 000**	**53 180**
2. Infrastructure and operating					
Rental of buildings and associated costs	**20**	**898 254**	**842 342**	**2 014 967**	**2 118 815**
ICT and data processing	**21**	**1 777 619**	**1 974 999**	**1 862 024**	**2 793 201**
Movable property and associated costs	**22**	**11 043**	**11 043**	**5 000**	**5 000**
Current administrative expenditure	**23**	**237 965**	**304 926**	**456 600**	**476 507**
Postage/telecommunications	**24**				
Meeting expenses	**25**	**10 404**	**10 404**	**30 000**	**34 623**
Running costs in connection with operational activities	**26**				
Information and publishing	**27**	**533 500**	**458 000**	**494 200**	**889 174**

Studies	**28**				
Other infrastructure and operating expenditure					
Total administrative (1 + 2)		**9 177 545**	**9 115 574**	**11 158 395**	**13 152 410**
3. Operational					
SESAR 2020 programme	**3**	736 000	51 047 975		50 469 584
Digital European sky programme	**4**	128 412 066	83 458 336	85 363 346	153 759 751
Total operational (3 + 4)		**129 148 066**	**134 506 311**	**85 363 347**	**204 229 335**
Title 5 - Unused Appropriations not required in current Year	5	**20 460 853**	**3 250 000**	**1 876 076**	**4 478 341**
Estimated total expenditure		**158 786 464**	**146 871 885**	**98 397 819**	**221 860 086**

Table 39: Final SESAR 3 JU expenditure 2022 and initial SESAR 3 JU expenditure 2023 – commitment & payment appropriations

3 Details on the budgetary steps

3.1 Final budget 2022 (as per third amended version of the BAWP 2022-2023 adopted by the GB of the SESAR 3 JU on 15 December 2022)

A second amendment to the budget 2022 was necessary for two operations in revenue:

- a frontloading payment of EUR 1 500 000 of financial contribution from EUROCONTROL, to the new DES programme;
- a payment of EUR 1 750 000 from the European Commission as a 100% pre-financing payment for the completion of the Delegation Agreement[24] on the technical assistance provided by the SESAR 3 JU for the preparation and monitoring of the DSD calls, in association with CINEA.

This additional revenue of EUR 3 250 000 is balanced with an additional equivalent amount in expenditure, under Title V “Unused appropriation not required in current year”.

3.1.1 Revenue

REVENUE	Initial Budget 2022		1st amending Budget 2022		2nd amending Budget 2022	
	Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations	Commitment appropriations	Payment appropriations
EU contribution (EFTA included) H2020		54 361 353		54 361 353		54 361 353
EU contribution (EFTA included) HE	128 412 066	83 458 336	128 412 066	83 458 336	128 412 066	83 458 336
EU contribution CEF funds					1 750 000	1 750 000
Other revenue	9 662 726	5 613 347	27 124 398	5 802 196	28 624 398	7 302 195
TOTAL REVENUES	**138 074 792**	**143 433 037**	**155 536 464**	**143 621 885**	**158 786 464**	**146 871 885**

Table 40: SESAR JU revenue 2022 – Commitment & Payment appropriations in EUR (after second amendment to the budget)

[24] Pending its signature by 31/12/2022

REVENUE	Initial Budget 2022		1st amending Budget 2022		C1 (SAP inscription)		2nd amending Budget 2022	
	Commitment	Payment	Commitment	Payment	Commitment	Payment	Commitment	Payment
1 REVENUE FROM FEES AND CHARGES								
2 EU CONTRIBUTION H2020		53 238 031		53 238 031	1 750 000	1 750 000	1 750 000	54 988 031
- of which Administrative (Title I and Title II) (Budget line 1101)		*3 244 911*		*3 244 911*				*3 244 911*
- of which Operational (Title III) (Budget line 1201)		*49 993 120*		*49 993 120*				*49 993 120*
- of which assigned revenues deriving from additional budget (Budget line 1300)					*1 750 000*	*1 750 000*	*1 750 000*	*1 750 000*
3 THIRD COUNTRIES CONTRIBUTION (incl. EFTA and candidate countries) H2020		1 123 322		1 123 322				1 123 322
- of which EFTA (2,11%)		*1 123 322*		*1 123 322*				*1 123 322*
- of which Candidate Countries								
4 EU CONTRIBUTION HE	126 280 927	81 928 697	126 280 927	81 928 697			126 280 927	81 928 697
- of which Administrative (Title I and Title II) (Budget line 1102)								
- of which Operational (Title IV) (Budget line 1202)	*126 280 927*	*81 928 697*	*126 280 927*	*81 928 697*			*126 280 927*	*81 928 697*
5 THIRD COUNTRIES CONTRIBUTION (incl. EFTA and candidate countries) HE	2 131 139	1 529 639	2 131 139	1 529 639			2 131 139	1 529 639
- of which EFTA (2,47%)	*2 131 139*	*1 529 639*	*2 131 139*	*1 529 639*			*2 131 139*	*1 529 639*
- of which Candidate Countries								
6 OTHER CONTRIBUTIONS (Budget lines 2101 + 3101)	4 158 552	4 158 552	4 158 552	3 338 937	1 500 000	1 500 000	5 658 552	4 838 936
7 ADMINISTRATIVE OPERATIONS								
8 REVENUES FROM SERVICES RENDERED AGAINST PAYMENT								
9 CORRECTION OF BUDGETARY IMBALANCES								
10 INTERESTS GENERATED								

11 BUDGET OUTTURN AND UNUSED APPROPRIATIONS FROM PREVIOUS YEARS	5 504 174	1 454 795	22 965 846	2 463 259			22 965 846	2 463 259
-of which for the running costs (H2020)	*4 768 174*	*1 454 795*	*19 265 846*	*2 463 259*			*19 265 846*	*2 463 259*
-of which for the operational costs (H2020)	*736 000*		*3 700 000*				*3 700 000*	
-of which for the running costs (HE)								
-of which for the operational costs (HE)								
TOTAL REVENUES	**138 074 792**	**143 433 037**	**155 536 464**	**143 621 885**	**3 250 000**	**3 250 000**	**158 786 464**	**146 871 885**

Table 41: Detailed SESAR 3 JU revenue 2022 in EUR (after second amendment to the budget)

3.1.2 Expenditure

EXPENDITURE	**Initial Budget 2022**		**1st amending Budget 2022**		**2nd amending Budget 2022**	
	Commitment appropriations	**Payment appropriations**	**Commitment appropriations**	**Payment appropriations**	**Commitment appropriations**	**Payment appropriations**
Title I	5 749 700	5 749 700	5 708 760	5 513 860	5 708 760	5 513 860
Title II	3 177 026	3 177 026	3 468 785	3 601 714	3 468 785	3 601 714
Title III	736 000	51 047 975	736 000	51 047 975	736 000	51 047 975
Title IV	128 412 066	83 458 336	128 412 066	83 458 336	128 412 066	83 458 336
Title V			17 210 853		20 460 853	3 250 000
TOTAL EXPENDITURE	**138 074 792**	**143 433 037**	**155 536 464**	**143 621 885**	**158 786 464**	**146 871 885**

Table 42: SESAR 3 JU expenditure per Title in 2022– Commitment & Payment appropriations in EUR (after second amendment to the budget)

			Commitment appropriations			
	Chapters	EXPENDITURE	Initial Budget 2022	1st amending Budget 2022	C1 (SAP inscription)	New budget in force
		Title I - Staff expenditure	**5 749 700**	**5 708 760**		**5 708 760**
	11	Salaries & allowances	5 364 700	5 323 760		5 323 760
1630	12	Expenditure relating to Staff recruitment	5 000	5 000		*5 000*
1510	13	Mission expenses	200 000	200 000		*200 000*
	14	Socio-medical infrastructure				
1610	15	Training	40 000	40 000		*40 000*
1640	16	External Services	90 000	90 000		*90 000*
	17	Receptions and events				
1620	19	Other Staff related expenditure	50 000	50 000		*50 000*
		Title II - Infrastructure and operating expenditure	**3 177 026**	**3 468 785**		**3 468 785**
	20	Rental of buildings and associated costs[*]	935 960	905 254		905 254
	21	Information and communication technology	1 568 619	1 777 619		1 777 619
2210	22	Movable property and associated costs	4 043	4 043		*4 043*
	23	Current administrative expenditure	274 000	237 965		237 965
	24	Postage / Telecommunications				
2510	25	Meeting expenses	10 404	10 404		*10 404*
	26	Running costs in connection with operational activities				
2310	27	Information and publishing	384 000	533 500		*533 500*
	28	Studies				
		Title III - Operational expenditure H2020	**736 000**	**736 000**		**736 000**
3400	3400	SESAR 2020 3.1 - Providing Strategic Steering to the SESAR programme	736 000	736 000		*736 000*
3500	3500	SESAR 2020 3.2 - Deliver Exploratory Research				

3600	3600	SESAR 2020 3.3 - Deliver Industrial Research and Validation				
3700	3700	SESAR 2020 3.4 - Deliver Very Large-Scale Demonstration activities				
3800	3800	SESAR 2020 3.5 - Deliver SESAR Outreach				
		Title IV - Operational expenditure Digital European Sky and SESAR 3 operations	**128 412 066**	**128 412 066**		**128 412 066**
40	40	SESAR 1 - 3.1 Studies/Development Conducted By the SJU	3 270 000	3 270 000		*3 270 000*
41	41	SESAR 1 - 3.2 Studies/Development Conducted By EUROCONTROL	23 845 000	23 845 000		*23 845 000*
42	42	SESAR 1 - 3.3 Studies/Development Conducted By Other Members	100 337 066	100 337 066		*100 337 066*
43	43	SESAR 2020 3.1 - Providing Strategic Steering to the SESAR programme				
44	44	SESAR 2020 3.2 - Deliver Exploratory Research	960 000	960 000		*960 000*
		Title V - Unused appropriations not required in current Year		**17 210 853**	**3 250 000**	**20 460 853**
5000	5000	Running costs (H2020)		14 246 853	3 250 000	*17 496 853*
5001	5001	Operational costs (H2020)		2 964 000		*2 964 000*
		TOTAL EXPENDITURE	**138 074 792**	**155 536 464**	**3 250 000**	**158 786 464**

Table 43: Detailed SESAR 3 JU expenditure 2022 – Commitment appropriations in EUR (after second amendment to the budget)

ABAC Budget line		EXPENDITURE	Payment appropriations			
			Initial Budget 2022	1st amending Budget 2022	*C1 (SAP inscription)*	New budget in force
		Title I - Staff expenditure	**5 749 700**	**5 513 860**		**5 513 860**
	11	Salaries & allowances	5 364 700	5 128 860		5 128 860
1630	12	Expenditure relating to Staff recruitment	5 000	5 000		*5 000*
1510	13	Mission expenses	200 000	200 000		*200 000*
	14	Socio-medical infrastructure				
1610	15	Training	40 000	40 000		*40 000*
1640	16	External Services	90 000	90 000		*90 000*
	17	Receptions and events				
1620	19	Other Staff related expenditure	50 000	50 000		*50 000*
		Title II - Infrastructure and operating expenditure	**3 177 026**	**3 601 714**		**3 601 714**
	20	Rental of buildings and associated costs[*]	935 960	849 342		849 342
	21	Information and communication technology	1 568 619	1 974 999		1 974 999
2210	22	Movable property and associated costs	4 043	4 043		*4 043*
	23	Current administrative expenditure	274 000	304 926		304 926
	24	Postage / Telecommunications				
2510	25	Meeting expenses	10 404	10 404		*10 404*
	26	Running costs in connection with operational activities				
2310	27	Information and publishing	384 000	458 000		*458 000*
	28	Studies				
		Title III - Operational expenditure H2020	**51 047 975**	**51 047 975**		**51 047 975**

3400	3400	SESAR 2020 3.1 - Providing Strategic Steering to the SESAR programme	929 684	929 684		*929 684*
3500	3500	SESAR 2020 3.2 - Deliver Exploratory Research	16 871 470	16 871 470		*16 871 470*
3600	3600	SESAR 2020 3.3 - Deliver Industrial Research and Validation	16 667 219	16 667 219		*16 667 219*
3700	3700	SESAR 2020 3.4 - Deliver Very Large-Scale Demonstration activities	15 295 870	15 295 870		*15 295 870*
3800	3800	SESAR 2020 3.5 - Deliver SESAR Outreach	1 283 732	1 283 732		*1 283 732*
		Title IV - Operational expenditure Digital European Sky and SESAR 3 operations	**83 458 336**	**83 458 336**		**83 458 336**
40	40	SESAR 1 - 3.1 Studies/Development Conducted By the SJU	700 000	700 000		*700 000*
41	41	SESAR 1 - 3.2 Studies/Development Conducted By EUROCONTROL	120 000	120 000		*120 000*
42	42	SESAR 1 - 3.3 Studies/Development Conducted By Other Members	81 678 336	81 678 336		*81 678 336*
43	43	SESAR 2020 3.1 - Providing Strategic Steering to the SESAR programme				
44	44	SESAR 2020 3.2 - Deliver Exploratory Research	960 000	960 000		*960 000*
		Title V - Unused appropriations not required in current Year			**3 250 000**	**3 250 000**
5000	5000	Running costs (H2020)			3 250 000	*3 250 000*
5001	5001	Operational costs (H2020)				
		TOTAL EXPENDITURE	**143 433 037**	**143 621 885**	**3 250 000**	**146 871 885**

Table 44: Detailed SESAR 3 JU expenditure 2022 – Payment appropriations in EUR (after second amendment to the budget)

3.2 Adoption of the budget 2023 (as per third amended version of the BAWP 2022-2023 adopted by the GB of the SESAR 3 JU on 15 December 2022)

The adoption of the 2023 budget of the SESAR 3 JU comes after a Draft Budget was submitted to the European Commission by the end of January 2022. The budget year 2023 is the next to last year of execution of the SESAR 2020 programme; 2023 represents a transition year.

The 2023 budget is also affected by the general economic context with the highest inflation rates in decades, which have also a direct impact on the level of salaries to be paid. This context creates high uncertainties for the future, after 2023.

3.2.1 Revenue

Revenue in the 2023 Budget is made of the usual elements:

- The running costs are covered with financial contribution paid by the three categories of Members: The European Union, EUROCONTROL and the other Members. For EUROCONTROL and the other Members, their financial contribution is still the one to be paid by application of the Membership agreement of SESAR 2020. Their financial contributions represent 5% of their declared and accepted in-kind contributions to operational expenses (IKOP). The European Union contributes with the payment appropriation corresponding to the commitment made in 2020 to frontload the end of the SESAR 2020 programme, but also with the first contribution to the Digital European Sky programme;

- The operational expenditure is covered with the sole contribution coming from the General Budget of the European Union. All contributions paid by the European Union are also complemented with a contribution coming from the European Free Trade Association (EFTA) member states and from the associated countries, if any.

Statement of revenue					
Title/chapter	**Heading**	**Financial year 2022**		**Financial year 2023**	
		Commitment appropriations	Payment appropriations	Estimate commitment appropriations	Estimate payment appropriations
EU contribution (excluding European Free Trade Association (EFTA) and third countries' contribution) ([25])	**1**	**126 280 927**	**135 166 728**	**91 833 792**	**89 996 348**
of which (fresh C1) administrative (Titles 1 and 2)				3 545 534	3 545 534
of which frontloaded commitments (Titles 1 and 2)	**1.1**		3 244 911	3 572 618	3 572 618
of which operational (Title 3 & 4)	**1.1**	86 280 927	111 921 817	82 965 640	81 128 196
Of which C2 Operational (Title 4)		40 000 000	20 000 000		
of which related to additional entrusted tasks				1 750 000	1 750 000
EFTA and non-EU countries' contribution	**1.1**	**2 131 139**	**2 652 962**	**2 587 702**	**2 478 276**
of which administrative EFTA (Titles 1 and 2)	**1.1**		68 468	189 995	189 995
of which administrative third countries excluding EFTA (Titles 1 and 2)	**1.1**				

([25]) This information has to be obtained by the joint undertakings from the parent Directorates-General when they work on the work programme or its update, as joint undertakings do not have an overview of the different fund sources that are included in the EU contribution. Even though the joint undertakings normally have an entry for the 'overall Union contribution received' (including EFTA and non-EU countries' contribution) under the contribution agreements, a breakdown of the EU contribution per fund source would allow the Commission financial services to cross-check it with the data already provided (from hearings, WD III and ABAC).

of which operational EFTA (Title 4)	**1.1**	2 131 139	2 584 494	2 397 707	2 288 281
of which operational third countries excluding EFTA (Title 3)	**1.1**				
Financial contribution from members other than the EU contribution	**2.1; 3.1**	**4 158 552**	**4 158 552**	**4 226 324**	**4 226 324**
of which administrative (Titles 1 and 2)		4 158 552	4 158 552	4 226 324	4 226 324
of which operational (Title 3)					
Financial contributing partners' contribution					
Interest generated					
Unused appropriations from previous years	**5.1**	**5 504 174**	**1 454 795**	**1 500 000**	**42 632 914**
of which administrative		4 768 174	1 454 795	1 500 000	1 500 000
of which operational		736 000			41 132 914
Total estimated revenue		**138 074 792**	**143 433 037**	**100 147 818**	**139 333 861**

Table 45: Initial SESAR 3 JU revenue 2022 and 2023 – commitment & payment appropriations

3.2.2 Expenditure

The expenditure part is made of five Titles now:

- Title I: Staff expenditure
- Title II: Infrastructure and operating expenditure

Titles I and II are for the running costs of the SESAR 3 JU.

- Title III: Operational expenditure for the SESAR2020 programme
- Title IV: Operational expenditure for the Digital European Sky (DES) programme

Titles III and IV are for the operational expenditure of the SESAR 3 JU, in particular for the contributions to the projects.

- Title V: Unused Appropriations not required in current Year

Title I: Staff expenditure

With an increase of EUR 745.904 (+13%) compared to the 2022 initial budget, Title I increases more than the inflation. The payment of the salaries represents EUR 710.242 of this increase and it can be explained by three factors:

- The salary index of 6.9% applied as of July 2022 will impact the entire year 2023 and another similar index of 6.9% has been extrapolated to be applied as of July 2023;
- The rather high level of vacancies in 2022 (Executive Director, Head of planning and reporting, all Grant managers) had a positive impact on the 2022 budget, but it also makes a significant increase with 2023 when all these positions are filled;
- A finding of the European Court of Auditors (ECA) in their 2022 audit may have an impact on the 2023 budget, should the European Commission decide to apply their conclusions. It relates to the way the contribution of the SESAR 3 JU to the pension scheme was calculated and invoiced by the central services of the European Commission. According to the ECA, the share of the Members other than the European Union was not taken into account and this should now be corrected.

Title II: Infrastructure and operating expenditure

Title II has an increase of EUR 1.685.765 compared to the 2022 initial budget. Even though a consistent 6% was applied to most budget lines in order to take the effect of the inflation into account, each budget line under this title have their own evolution:

- Rental of building and associated costs: the increase of EUR 1.086.007 compared to 2022 initial budget is mainly due to the move of the SESAR 3 JU offices to EUROCONTROL. The lease contract for the Cortenbergh offices foresees that the rent is due until February 2025, with no possibility of early termination. Therefore, when the move occurs (end of February 2023), the SESAR 3 JU has to pay an amount corresponding to the sum of rents until February 2025 (with a margin of 100k€ for possible future rent index). An amount of 189k€ is also necessary to put the Cortenbergh offices back in their initial stage after the move to EUROCONTROL (so called “dilapidation” costs). On top of these amounts, a limited rent has to be paid to EUROCONTROL, but many contracts linked to the Cortenbergh building (security, cleaning, etc) can be stopped, as the equivalent services will be provided by EUROCONTROL with no additional costs. The savings will appear in the 2024 budget;
- ICT and data processing: An increase of 235k€ corresponds to the indexed prices estimated for 2023 by EUROCONTROL that provides the SESAR 3 JU with some IT services. Another 115k€ is necessary to meet new obligations on cyber-security. These increases are partially offset with a cut of 100k€ linked to reduced costs of services once the SESAR 3 JU has moved to the EUROCONTROL premises;
- Information and publishing: an increase of 110k€ due to additional events and to the expected increased costs of the Airspace World in Geneva compared to Madrid.

Title III: Operational expenditure for the SESAR2020 programme

No more commitment appropriation since 2021 (all SESAR2020 grant agreements signed before that year). An amount of 50.5M€ in payment appropriation for the final payments of the last SESAR2020 projects ending end of 2022 – beginning of 2023.

Title IV: Operational expenditure for the Digital European Sky (DES) programme

85M€ in commitment appropriation, in complement of those already in the 2022 budget, for the signature of new DES grant agreements (ER1, IR1) and 66.4M€ in payment appropriation for corresponding pre-financing payments.

STATEMENT OF EXPENDITURE					
Title Chapter	**Heading**	**Financial YEAR 2022**		**Financial YEAR 2023**	
		Commitment appropriations	Payment appropriations	Estimate commitment appropriations	Estimate payment appropriations
1. Staff					
Salaries and allowances	**11**	**5 364 700**	**5 364 700**	**5 874 942**	**6 074 942**
of which establishment plan posts		4 700 000	4 700 000	5 250 000	5 450 000
of which external personnel		664 700	664 700	624 942	624 942
Expenditure relating to staff recruitment	**12**	**5 000**	**5 000**	**6 600**	**6 600**
Mission expenses	**13**	**200 000**	**200 000**	**230 000**	**230 000**
Socio-medical infrastructure	**14**				
Training	**15**	**40 000**	**40 000**	**48 812**	**48 812**
External services	**16**	**90 000**	**90 000**	**82 250**	**82 250**

Receptions, events and representation	**17**				
Social welfare	**18**				
Other staff-related expenditure	**19**	**50 000**	**50 000**	**53 000**	**53 000**
2. Infrastructure and operating					
Rental of buildings and associated costs	**20**	**928 960**	**928 960**	**2 014 967**	**2 014 967**
ICT and data processing	**21**	**1 568 619**	**1 568 619**	**1 862 024**	**1 862 024**
Movable property and associated costs	**22**	**12 000**	**12 000**	**5 000**	**5 000**
Current administrative expenditure	**23**	**273 043**	**273 043**	**456 600**	**456 600**
Postage/telecommunications	**24**				
Meeting expenses	**25**	**10 404**	**10 404**	**30 000**	**30 000**
Running costs in connection with operational activities	**26**				
Information and publishing	**27**	**384 000**	**384 000**	**494 200**	**494 200**
Studies	**28**				

Other infrastructure and operating expenditure					
Total administrative (1 + 2)		**8 926 726**	**8 926 726**	**11 158 395**	**11 358 395**
3. Operational					
SESAR 2020 programme	**3**	736 000	51 047 975		50 469 584
Digital European sky programme	**4**	128 412 066	83 458 336	85 363 347	70 301 865
Total operational (3 + 4)		**129 148 066**	**134 506 311**	**85 363 347**	**120 771 449**
Title 5 - Unused Appropriations not required in current Year	5			**3 626 077**	**7 204 017**
Estimated total expenditure		**138 074 792**	**143 433 037**	**100 147 818**	**139 333 861**

Table 46: Initial SESAR 3 JU expenditure 2022 and 2023 – commitment & payment appropriations

3.3 First amending budget 2023 (as per the fourth amended version of the BAWP 2022-2023 adopted by the GB of the SESAR 3 JU on 02/06/2023)

3.3.1 Revenue

An inscription of payment appropriations is necessary to cover payment of commitments carried over from 2022 to 2023. The inscription of payment appropriations is covered by cash already received from S3JU's Members.

The inscription of additional budget €84.276.225 will occur through the re-inscription of unused appropriations recorded at 2022 year-end accounts' closure in Title II (EUR 818 339, which serves to cover EUROCONTROL's contribution to IT services) and Title IV (EUR 83 457 886, necessary for the first pre-financing payments under the ER1 and IR1 calls).

REVENUE	**Heading**	**1st amending Budget 2023**				
		Commitment appropriations				
		Initial Budget 2023 (EUR)	Transfers 2023	1st amending Budget 2023 (EUR)	Budget 2023 in force (EUR)	VAR initial 2023/final 2023 (%)
1 EU CONTRIBUTION		**86 511 174**			**86 511 174**	
-Of which (fresh C1) Administrative (Title 1 and Title 2) Horizon Europe	11	3 545 534			3 545 534	
-Of which frontloading (Title 1 and Title 2) Horizon 2020	11					
-Of which Operational (Title 3) Horizon 2020	12					
-Of which Operational (Title 4) Horizon Europe	12	82 965 640			82 965 640	
-Of which C2 Administrative (Title 1 and Title 2) Horizon 2020	11					
-Of which C2 Administrative (Title 1 and Title 2) Horizon Europe	11					
-Of which C2 Operational (Title 3) Horizon 2020	12					
-Of which C2 Operational (Title 4) Horizon Europe	12					

-Of which CEF Funds (management fees)	12					
2 THIRD PARTIES CONTRIBUTION	**11 & 12**	**2 500 171**			**2 500 171**	
-Of which EEA/EFTA (excl. Switzerland) Horizon 2020	11 & 12	102 466			102 466	
-Of which EEA/EFTA (excl. Switzerland) Horizon Europe	11 & 12	2 397 705			2 397 705	
-Of which third countries	11 & 12					
3 IN CASH THIRD PARTY CONTRIBUTIONS		**4 226 325**			**4 226 325**	
-Of which Administrative (Title 1 and Title 2) Horizon 2020	21 &31	4 226 325			4 226 325	
-Of which Administrative (Title 1 and Title 2) Horizon Europe	21 &31					
-Of which Operational						
4 REVENUES FROM SERVICES RENDERED AGAINST PAYMENT						
5 INTERESTS GENERATED						
6 UNUSED APPROPRIATIONS FROM PREVIOUS YEARS		**5 160 147**			**5 160 147**	
-Of which administrative Horizon 2020	51	3 660 147			3 660 147	
-Of which administrative Horizon Europe	51	1 500 000			1 500 000	
-Of which administrative CEF funds (management fees)	51					
-Of which operational Horizon 2020	51					
-Of which operational Horizon Europe	51					
7 OTHER	**43 & 44**					
TOTAL		**98 397 817**			**98 397 817**	

Table 47: Revenue 2023 - commitment appropriations

REVENUE	Heading	1st amending Budget 2023				
		Payment appropriations				
		Initial Budget 2023 (EUR)	Transfers 2023	1st amending Budget 2023 (EUR)	Budget 2023 in force (EUR)	VAR initial 2023/final 2023 (%)
1 EU CONTRIBUTION		**88 246 348**			**88 246 348**	
-Of which (fresh C1) Administrative (Title 1 and Title 2) Horizon Europe	11	3 545 534			3 545 534	
-Of which frontloading (Title 1 and Title 2) Horizon 2020	11	3 572 618			3 572 618	
-Of which Operational (Title 3) Horizon 2020	12	12 800 987			12 800 987	
-Of which Operational (Title 4) Horizon Europe	12	68 327 209			68 327 209	
-Of which C2 Administrative (Title 1 and Title 2) Horizon 2020	11					
-Of which C2 Administrative (Title 1 and Title 2) Horizon Europe	11					
-Of which C2 Operational (Title 3) Horizon 2020	12					
-Of which C2 Operational (Title 4) Horizon Europe	12					
-Of which Horizon Europe CEF Funds (management fees)	12					
2 THIRD PARTIES CONTRIBUTION	**11 & 12**	**2 478 276**			**2 478 276**	
-Of which EEA/EFTA (excl. Switzerland) Horizon 2020	11 & 12	189 995			189 995	
-Of which EEA/EFTA (excl. Switzerland) Horizon Europe	11 & 12	2 288 281			2 288 281	
-Of which third countries	11 & 12					
3 IN CASH THIRD PARTY CONTRIBUTIONS		**4 226 324**		**818 339**	**5 044 663**	**19,36**
--Of which Administrative (Title 1 and Title 2) Horizon 2020	21 &31	4 226 324		818 339	5 044 663	19,36
-Of which Administrative (Title 1 and Title 2) Horizon Europe	21 &31					

of which Operational						
4 REVENUES FROM SERVICES RENDERED AGAINST PAYMENT						
5 INTERESTS GENERATED						
6 UNUSED APPROPRIATIONS FROM PREVIOUS YEARS		**42 632 914**		**83 457 886**	**126 090 800**	**195,76**
-Of which administrative Horizon 2020	51					
-Of which administrative Horizon Europe	51	1 500 000			1 500 000	
-Of which administrative CEF funds (management fees)	51					
-Of which operational Horizon 2020	51	21 132 914			21 132 914	
-Of which operational Horizon Europe	51	20 000 000		83 457 886	103 457 886	417,29
7 OTHER	**43 & 44**					
TOTAL		**137 583 861**		**84 276 225**	**221 860 086**	**61,25**

Table 48: Revenue 2023 - payment appropriations

3.3.2 Expenditure

The expenditure part is made of five Titles now:

- Title I: Staff expenditure.
- Title II: Infrastructure and operating expenditure.
- Title III: Operational expenditure for the SESAR2020 programme.
- Title IV: Operational expenditure for the Digital European Sky (DES) programme.
- Title V: Unused Appropriations not required in current Year.

Where, Titles I and II are for the running costs of the SESAR 3 JU and Titles III and IV are for the operational expenditure of the SESAR 3 JU, in particular for the contributions to the projects.

Unused payment appropriations, amount to € 975 677, from previous years already inscribed in Title V, will be transferred to Title I (amount of €339 486) and Title II (amount of € 636 191), as follows:

Title I: Staff expenditure: an increase by € 339 486 in payment appropriations is planned.

- A transfer of € 193 689 in payment appropriations is foreseen to cover the possible consequences of a finding of the European Court of Auditors' 2022 audit. Their finding applies to all Joint Undertakings and is directed to the European Commission that has never invoiced the JU for a contribution to the pension scheme to be paid by the Members other than the Union. If this decision is invoiced by DG BUDGET, the payment should take place this year.
- Furthermore, a transfer of € 85 274 in payment appropriations is necessary to cover legal obligations related to interims and trainees. The remaining transfer amounting to € 60 523 covers other staff expenditure such as missions, recruitment expenditure and HR support fees.

Title II: Infrastructure and operating expenditure:

- An increase by € 636 191 in payment appropriations is planned.
- ICT and data processing: an amount of € 112 838 is necessary in payment appropriations to cover the previous year's legal obligations carried over to 2023.
- Information and publishing (communication): the amount of € 394 974 in commitments carried over to 2023 relates to the several events organised in 2022 for the launch of the new SESAR 3 JU and for its first Annual Conference. An equal transfer in payment appropriations is required to ensure payment towards these obligations.
- Furthermore, it is necessary to correct EUROCONTROL's first contribution to the Horizon Europe programme, which amounted to € 1 500 000. The corresponding debit note was established end of 2022 but only paid early 2023. In the initial budget 2023, these appropriations were correctly re-inscribed on the revenue side as unused appropriations from 2022. On the contrary, on the expenditure side, the appropriations were wrongly inscribed as fresh credits instead of being re-inscribed as unused appropriations.

Title III: Operational expenditure for the SESAR2020 programme:

- No further payment appropriations needed.

Title IV: Operational expenditure for the Digital European Sky (DES) programme:

- As indicated in the section revenue € 83 457 886 will be made available through a re-inscription of payment appropriations not through transfer.

EXPENDITURE	Heading	1st amending Budget 2023

		Commitment appropriations				
		Initial Budget 2023 (EUR)	Transfers 2023	1st amending Budget 2023 (EUR)	Budget 2023 in force (EUR)	VAR initial 2023/final 2023 (%)
Title 1 - Staff expenditure		**6 295 604**			**6 295 604**	
Salaries and allowances	**11**	**5 874 942**			**5 874 942**	
of which establishment plan posts		5 250 000			5 250 000	
of which external personnel		624 942			624 942	
Expenditure relating to staff recruitment	**12**	**6 600**			**6 600**	
Mission expenses	**13**	**230 000**			**230 000**	
Socio-medical infrastructure	**14**					
Training	**15**	**48 812**			**48 812**	
External services	**16**	**82 250**			**82 250**	
Receptions, events and representation	**17**					
Social welfare	**18**					
Other staff-related expenditure	**19**	**53 000**			**53 000**	
Title 2 - Infrastructure and operating expenditure		**4 862 791**			**4 862 791**	
Rental of buildings and associated costs	**20**	**2 014 967**			**2 014 967**	
ICT and data processing	**21**	**1 862 024**			**1 862 024**	
Movable property and associated costs	**22**	**5 000**			**5 000**	
Current administrative expenditure	**23**	**456 600**			**456 600**	
Postage/telecommunications	**24**					
Meeting expenses	**25**	**30 000**			**30 000**	
Running costs in connection with operational activities	**26**					
Information and publishing	**27**	**494 200**			494 200	

Studies	**28**					
Other infrastructure and operating expenditure						
Titles 3 & 4 - Operational expenditure		**85 363 346**			**85 363 346**	
SESAR 2020 programme	**30**					
Digital European sky programme	**40**	**85 363 346**			**85 363 346**	
Title 5 - Unused Appropriations not required in current Year		**1 876 076**			**1 876 076**	
Administrative Horizon 2020	**50**					
Administrative assigned revenue	**50**					
Administrative Horizon Europe	**50**	**1 876 076**			**1 876 076**	
Operational Horizon 2020	**51**					
Operational Horizon Europe	**51**					
TOTAL		**98 397 817**			**98 397 817**	

Table 49: Expenditure 2023 - commitment appropriations

EXPENDITURE	**Heading**	**1st amending Budget 2023**				
		Payment appropriations				
		Initial Budget 2023 (EUR)	Transfers 2023 (EUR)	1st amending Budget 2023 (EUR)	Budget 2023 in force (EUR)	VAR initial 2023/final 2023 (%)
Title 1 - Staff expenditure		**6 495 604**		**339 486**	**6 835 090**	**5,23**
Salaries and allowances	**11**	**6 074 942**		**278 963**	**6 353 905**	**4,59**
of which establishment plan posts		5 450 000		193 689	5 643 689	**3,55**
of which external personnel		624 942		85 274	710 215	**13,65**
Expenditure relating to staff recruitment	**12**	**6 600**		**603**	**7 203**	**9,14**

Mission expenses	**13**	**230 000**		**57 740**	**287 740**	**25,10**
Socio-medical infrastructure	**14**					
Training	**15**	**48 812**			**48 812**	
External services	**16**	**82 250**		**2 000**	**84 250**	**2,43**
Receptions, events and representation	**17**					
Social welfare	**18**					
Other staff-related expenditure	**19**	**53 000**		**180**	**53 180**	**0,34**
2. Infrastructure and operating		**4 862 791**		**1 454 530**	**6 317 321**	**29,91**
Rental of buildings and associated costs	**20**	**2 014 967**		**103 848**	**2 118 815**	**5,15**
ICT and data processing	**21**	**1 862 024**		**931 177**	**2 793 201**	**50,01**
Movable property and associated costs	**22**	**5 000**			**5 000**	
Current administrative expenditure	**23**	**456 600**		**19 907**	**476 507**	**4,36**
Postage/telecommunications	**24**					
Meeting expenses	**25**	**30 000**		**4 623**	**34 623**	**15,41**
Running costs in connection with operational activities	**26**					
Information and publishing	**27**	**494 200**		394 974	889 174	**79,92**
Studies	**28**					
Other infrastructure and operating expenditure						
Titles 3 & 4 - Operational expenditure		**120 771 449**		**83 457 886**	**204 229 335**	**69,10**
SESAR 2020 programme	**30**	**50 469 584**			**50 469 584**	
Digital European sky programme	**40**	**70 301 865**		**83 457 886**	**153 759 751**	**118,71**
Title 5 - Unused Appropriations not required in current Year		**5 454 017**		**- 975 677**	**4 478 341**	**-17,89**
Administrative Horizon 2020	**50**					
Administrative assigned revenue	**50**					
Administrative Horizon Europe	**50**	1 676 076		- 975 677	700 400	**-58,21**
Operational Horizon 2020	**51**	-16 222 059			-16 222 059	

Operational Horizon Europe	**51**	20 000 000			20 000 000	
Total expenditure		**137 583 861**		**84 276 225**	**221 860 086**	**61,25**

Table 50: Expenditure 2023 - payment appropriations

Annexes

1 Annex I. Annual additional activities plan

Article 11 of the Single Basic Act states that the contributions of private members shall consist of financial contributions and of any of the following:

a) in-kind contributions to operational activities;
b) in-kind contributions to additional activities, approved by the governing board in accordance with Article 17(2), point (n).

Article 17(2)(n) specifies that the Governing Board shall "*approve the annual additional activities plan, set out in an annex to the main part of the work programme, on the basis of a proposal from the members other than the Union and after having consulted the scientific advisory body or such body as set out in Part Two and after taking into consideration the states' representatives group's opinion*".[26]

The Members other than the European Union were requested to provide the SESAR 3 JU with their detailed information about the additional activities planned in 2022 and 2023. The information provided was put together in a single file and assessed against the criteria defined in the regulation. The 2022 Additional Activities Plan and the 2023 Additional Activities Plan presented below represent a consolidated view of the amounts declared, per category of AA, following the template provided by the European Commission.

The AA figures from EUROCONTROL are presented in a separate table for reporting reasons, as their obligation to reach up to 500M€ contribution (Art. 146(2)) is different from the one of the other Members to reach at least 500M€ contribution (Art.146(1)).

The costs relating to "scope a) activities covering all the non-Union funded part of the Single European Sky ATM Research projects that contribute to the achievement of the agreed work programme of the Joint Undertaking" planned for 2022 were rejected as there were no SESAR 3 projects signed yet (SESAR 2020 projects are already accounted under the SESAR 2020 IKOP procedure). For the costs declared for 2023 under scope a), a 20% cut has been applied to all declared figures in order to take into account the estimated success rate of the Members (80%).

[26] In line with Article 17.2.(n) of the SBA the annual additional activities plans for years 2022 and 2023 take into consideration the states' representatives group's opinion. The Scientific Committee could not be consulted as its establishment and ramp-up was ongoing during the drafting and validation process of this document.

1.1 2022 Annual additional activities plan - EUROCONTROL

OVERVIEW ESTIMATED IKAA FOR 2022[1]						
Category of the additional activities (AA)[2]	Description of the AAs[3]	Contribution to JU objectives or KPIs of the JU[4]	Link to specific JU project/call/topic[5]	Estimated value AA for 2022 (in M€)	Estimated value AA for 2022 (in M€) - Rejected by GB	Estimated value AA for 2022 (in M€) - Accepted by GB
[Support to additional R&I][7]						
				3,100	0,000	3,100
[Scale up of technologies]						
				2,500	0,000	2,500
[Demonstrators]						
				0,020	0,002	0,018
[Creating new business opportunities]						
				0,000	0,000	0,000
[Training & skilling development]						
				0,000	0,000	0,000
[Contribution to the development of new standards, regulations and policies]						
				0,900	0,120	0,780
[Supporting ecosystem development]						
				0,820	0,000	0,820
[Communication, dissemination, awareness raising, citizen engagement]						
				0,060	0,000	0,060
[Others]						
				0,000		
TOTAL ESTIMATED IKAA				€7,400	€0,122	€7,278

1.2 2022 Annual additional activities plan – Other Members

Category of the additional activities (AA)[2]	Description of the AAs[3]	Contribution to JU objectives or KPIs of the JU[4]	Link to specific JU project/call/topic[5]	Estimated value AA for 2022 (in M€)	Estimated value AA for 2022 (in M€) - Rejected by GB	Estimated value AA for 2022 (in M€) - Accepted by GB
[Support to additional R&I][7]						
				0,267	0,067	0,200
[Scale up of technologies]						
				45,631	0,000	45,631
[Demonstrators]						
				0,595	0,000	0,595
[Creating new business opportunities]						
				0,080	0,000	0,080
[Training & skilling development]						
				0,000	0,000	0,000
[Contribution to the development of new standards, regulations and policies]						
				3,515	0,000	3,515
[Supporting ecosystem development]						
				24,339	0,000	24,339
[Communication, dissemination, awareness raising, citizen engagement]						
				0,168	0,000	0,168
[Others]						
				9,115	0,173	8,942
TOTAL ESTIMATED IKAA				€83,710	€0,240	€83,470

1.3 2023 Annual additional activities plan – EUROCONTROL

OVERVIEW ESTIMATED IKAA FOR 2023[1]						
Category of the additional activities (AA)[2]	Description of the AAs[3]	Contribution to JU objectives or KPIs of the JU[4]	Link to specific JU project/call/topic[5]	Estimated value AA for 2023 (in M€)	Estimated value AA for 2023 (in M€) - Rejected by GB	Estimated value AA for 2023 (in M€) - Accepted by GB
[Support to additional R&I][7]						
				4,600	0,000	4,600
[Scale up of technologies]						
				4,680	0,000	4,680
[Demonstrators]						
				6,750	0,008	6,742
[Creating new business opportunities]						
				0,100	0,000	0,100
[Training & skilling development]						
				0,000	0,000	0,000
[Contribution to the development of new standards, regulations and policies]						
				5,550	0,120	5,430
[Supporting ecosystem development]						
				5,490	0,000	5,490
[Communication, dissemination, awareness raising, citizen engagement]						
				0,250	0,000	0,250
[Others]						
				0,000		
TOTAL ESTIMATED IKAA				€27,420	€0,128	€27,292

1.4 2023 Annual additional activities plan – Other Members

OVERVIEW ESTIMATED IKAA FOR 2023[1]						
Category of the additional activities (AA)[2]	Description of the AAs[3]	Contribution to JU objectives or KPIs of the JU[4]	Link to specific JU project/call/topic[5]	Estimated value AA for 2023 (in M€)	Estimated value AA for 2023 (in M€) - Rejected by GB	Estimated value AA for 2023 (in M€) - Accepted by GB
[Support to additional R&I][7]						
				9,075	1,737	7,338
[Scale up of technologies]						
				69,884	0,000	69,884
[Demonstrators]						
				24,774	0,063	24,711
[Creating new business opportunities]						
				0,550	0,000	0,550
[Training & skilling development]						
				0,005	0,000	0,005
[Contribution to the development of new standards, regulations and policies]						
				6,501	0,000	6,501
[Supporting ecosystem development]						
				21,830	0,000	21,830
[Communication, dissemination, awareness raising, citizen engagement]						
				0,184	0,000	0,184
[Others]						
				7,799	0,096	7,703
TOTAL ESTIMATED IKAA				140,602	1,895	138,706

2 Annex II. Calls for proposals – Full description

According to the Horizon Europe rules, and in order to protect Union interests, the right for joint undertaking to object to transfers of ownership of results or to grants of an exclusive licence regarding results should apply to participants. Therefore, the provisions set out in General Annex G to the Horizon Europe work programmes on the right to object apply generally. It should be noted that in accordance with the SBA and the MGA, the right to object applies also to participants that have not received funding from the JU and for the periods set therein.

2.1 Call HORIZON-SESAR-2022-DES-ER-01

2.1.1 Scope of the call

This call is composed of three work areas.

- **WA1 (fundamental science and outreach)** comprises the exploratory research necessary to develop new concepts for ATM beyond those identified in the European ATM Master Plan, and will help to develop emerging technologies and methods to the level of maturity required to feed the applied research conducted by the SESAR 3 JU. This area of research is structured around the same flagships identified in the rest of the programme to ensure that there is a logical and structured flow of ideas and results across the whole programme.
- **WA2 (ATM application-oriented research)** comprises the exploratory research aiming to bridge the results of ATM excellent science and outreach and the higher maturity ATM research performed with the wider research community, as part of SESAR 3 JU industrial research activities. It also aims to provide the necessary scientific support to ATM change.
- **WA3 (knowledge transfer network)** provides support for the SESAR 3 JU to continue supporting the overarching view across ATM exploratory research that was established in SESAR 2020, providing a coordinated exchange of research knowledge across a wide range of relevant themes and, within the context of this networking, helps to further stimulate the future ATM skilled workforce. The challenge is to support and encourage collaborative research on future and emerging innovative ideas, expertise and knowledge for the benefit of the future evolution of the European ATM system and its people.

2.1.2 General conditions for the call

Unless otherwise stated, the call follows the general conditions laid down in the General Annexes to the Horizon Europe Work Programme for 2021–2022, adopted by the European Commission ([27]).

Topic	Type of actions	Budget (million EUR) for 2022	Maximum expected EU contribution per project (million EUR) ([28])

([27]) European Commission Decision C(2021)1940 of 31 March 2021.
([28]) Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.

Opening: 7 April 2022 Deadline ([29]): 13 October 2022			
HORIZON-SESAR-2022-DES-ER1-WA1-1	Research and innovation action (RIA)	10.00	1.00
HORIZON-SESAR-2022-DES-ER1-WA1-2			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-3			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-4			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-5			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-6			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-7			1.00
HORIZON-SESAR-2022-DES-ER1-WA1-8			1.00
HORIZON-SESAR-2022-DES-ER1-WA2-1	Research and Innovation Action (RIA)	10.00	2.00
HORIZON-SESAR-2022-DES-ER1-WA2-2			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-3			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-4			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-5			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-6			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-7			2.00
HORIZON-SESAR-2022-DES-ER1-WA2-8			2.00
HORIZON-SESAR-2022-DES-ER1-WA3-1	Coordination and support action (CSA)	3.75	N/A
Overall indicative budget		23.75[30]	

Table 51: Budget allocation and maximum expected EU contribution per project per work area under the HORIZON-SESAR-2022-DES-ER-01 call for proposals

Type of conditions	**Information on the conditions**
Admissibility conditions	The conditions are described in General Annex A to the Horizon Europe work programme for 2021–2022.
Eligibility conditions	The conditions are described in General Annex B to the Horizon Europe work programme for 2021–2022.

([29]) The Executive Director responsible may delay the deadline(s) by up to 2 months. All deadlines are at 17.00.00 Brussels local time.

([30]) The new overall indicative budget is million EUR 22.29.

Financial and operational capacity and exclusion	The criteria are described in General Annex C to the Horizon Europe work programme for 2021–2022.
Award criteria	The criteria are described in subsection 2.1.3 below.
Documents	The documents are described in General Annex E to the Horizon Europe work programme for 2021–2022.
Procedure	The procedure is described in General Annex F to the Horizon Europe work programme for 2021–2022. The following exception applies: to ensure a balanced portfolio, grants will be awarded to applications not only in order of ranking but at least also to those that are the highest ranked within topics within the same work area, provided that the application attains the threshold.
Legal and financial set-up of the grant agreements	The rules are described in General Annex G to the Horizon Europe work programme for 2021–2022. The following exceptions apply. 1) Beneficiaries will be subject to the following additional dissemination obligations: ○ beneficiaries must make proactive efforts to share, on a royalty-free basis, in a timely manner and as appropriate, all relevant results with the other grants awarded under the same call; ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement. 2) Beneficiaries will be subject to the following additional exploitation obligations: For the purpose of complying with the objectives set in Council Regulation (EU) 2021/2085, the SRIA and the European ATM Master Plan; ○ beneficiaries must make available for reuse under fair, reasonable and non-discriminatory conditions all relevant results generated, through a well-defined mechanism using a trusted repository; ○ if the purpose of the specific identified measures to exploit the results of the action is related to standardisation, beneficiaries must grant a non-exclusive licence to the results royalty-free; ○ if working on linked actions, beneficiaries must ensure mutual access to the background to and to the results of ongoing and closed linked actions, should this be necessary to implement tasks under the linked actions or to exploit results generated by the linked actions as defined in the conditions laid down in this biannual work programme and in the call for proposals; ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement.
Other conditions	The integration of a gender dimension (sex and gender analysis) into R&I content is not a mandatory requirement.

Table 52: General conditions for the HORIZON-SESAR-2022-DES-ER-01 call for proposals

2.1.3 Award criteria

Exploratory research (WA1 and WA2)

Type of actions	**Excellence** *(The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)*	**Impact**	**Implementation**
Research and innovation actions (RIA)	1. Clarity and pertinence of the proposal: degree to which the objectives, scope and requirements set out in the call material are well understood and fully addressed. 2. Soundness of the proposed methodology for developing the SESAR solutions, including the underlying concepts, models, assumptions and interdisciplinary approaches. This criterion also includes appropriate consideration of the integration of a gender dimension into R&I content and the quality of open science practices ([31]), including sharing and management of research outputs and engagement of citizens, civil society and end users where appropriate. 3. Level of awareness of the state of the art: degree to which the proposal demonstrates knowledge of current operations and relevant previous R&D work (both within and outside SESAR), explains how the proposed work will go beyond	1. Credibility of the pathways to achieve the expected outcomes and impacts specified in the call material. 2. Suitability and quality of the measures in terms of maximising expected outcomes and impacts, as set out in the dissemination and exploitation (D&E) plan, including communication activities.	1. Quality and effectiveness of the work plan and assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. 2. Capacity and role of each participant and the extent to which the consortium as a whole brings together the necessary expertise.

([31]) See EU's open science policy (https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en).

	the state of the art and demonstrates innovation potential.		

Knowledge transfer network (WA3)

Type of actions	Excellence *(The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)*	Impact	Implementation
Coordination and support actions (CSAs)	1. Clarity and pertinence of the project's objectives. 2. Quality of the proposed coordination and/or support measures, including soundness of methodology	1. Credibility of the pathways to achieve the expected outcomes and impacts specified in the call material, and on ATM research. 2. Suitability and quality of the measures in terms of maximising expected outcomes and impacts, as set out in the D&E plan, including communication activities.	1. Quality and effectiveness of the work plan and assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. 2. Capacity and role of each participant, and the extent to which the consortium as a whole brings together the necessary expertise.

2.1.4 Specific conditions and description of topics for each work area

2.1.4.1 *Work Area 1: Fundamental science and outreach*

Specific conditions for WA1	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 1.00 million would allow the outcomes to be addressed appropriately. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 10.00 million
Type of actions	Research and innovation action (RIA)
Legal and financial set-up of the grant agreement	Grants awarded under this work area will have to submit the following deliverables: • Concept outline • Exploratory research plan (ERP) • Exploratory research report (ERR)

	• Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated)
Other requirements	The maximum project duration is 30 months, including a 6-month period at the end of the project life cycle to undertake communications, dissemination and exploitation activities in relation to the research results.

2.1.4.1.1 *Topic HORIZON-SESAR-2022-DES-ER1-WA1-1: Fundamental science and outreach for connected and automated ATM*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that the proposed solutions would have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint.
- **Capacity.** Project results are expected to contribute to capacity by improving runway use and ground operations, as well as the use of medium/high density en-route airspace.
- **Cost-efficiency.** Project results are expected to justify the investment costs related to the adoption of automated technologies and tools.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system, in a more connected and automated environment.
- **Security.** Project results are expected to identify the potential risks deriving from having a more interconnected and automated ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the connected and automated ATM flagship.

- **Applications of innovative technologies from outside ATM.** The scope is to investigate the potential usage, integration and interoperability of innovative technologies operating outside the spectrum currently used in aviation that can maintain, as overarching principles, the high level of integrity and safety required in ATM while reducing costs and optimising spectrum usage (*R&I need: enabling the deployment of a performance-based CNS service offer*).
- **Combined and integrated KPIs and performance structure for technological solutions / cost–benefit analyses (CBAs).** This element covers the creation of performance

frameworks (e.g. KPAs, KPIs) to support the performance assessment of technological solutions and facilitate the development of CBAs that can help in justifying the deployment of future technologies (*R&I need: enabling the deployment of a performance-based CNS service offer*).

- **Moving from magnetic to geographical bearings.** In order to enable a performance-based CNS service offer, research on moving from magnetic to geographical bearings is required. The objective is to study what would be needed from a CNS and avionics perspective (including, for example, flight management system (FMS), surveillance) and also to investigate the operational aspects (e.g. pilots, ATCOs, procedure design) that would need to be addressed. An estimation of the potential benefits would also be required (*R&I need: enabling the deployment of a performance-based CNS service offer*).
- **Land behind without runway vacated.** The scope is to investigate the European "land behind without runway vacated" concept, similar to the FAA "land behind" clearance. Today, in the case of long runways, landing aircraft may be allowed to use the runway simultaneously under certain circumstances, or clearance to land may be given before the previous aircraft has crossed the threshold (*R&I need: runway use optimisation through integrated use of arrival and departure time-based separation (TBS) tools)*.
- **Use of slant visual range beyond runway visual range.** This research is about the technical and operational use of slant visual range beyond runway visual range. In fact, runway visual range, although it has been used for decades, does not take into consideration important variables (e.g. reduced visibility caused by factors such as rain on the windshield of the aircraft) (*R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Auto-steer aircraft taxi operations at airport.** The scope is to investigate the integration of automotive into aviation technology for taxiways ('green taxiing'), to move towards a fully automated system for all surface operations. The investigation should cover both the technology and the operational challenges (*R&I need: airport automation including runway and surface movement assistance for more predictable ground operations)*.
- **Automated ATC in medium-/high-density en-route airspace** (including the evolution of the role of the human in an environment with higher levels of automation): this research into automated ATC in medium-/high-density en-route airspace investigates the move of the role of the human from executive to supervisory control, addressing the related challenges to ensure that the proposed solution is fully consistent with human capabilities. It involves developing operational concepts for higher levels of automation in ATM (e.g. delegation of control to the automated system) both at aircraft level and at ground level and addressing the specific challenges that hinder the application of ML and AI methods to the further automation of ATM (e.g. transparency, generalisation). It also addresses the recommendations provided by the Expert Group on the Human Dimension of the Single European Sky, reviewing all the roles, responsibilities and tasks of the different actors (airborne and ground, ATM and U-space, operational and technical), as well as training needs and change management in relation to evolving roles in an environment with higher levels of automation (*R&I need: role of the human)*.
- **Autonomous runway inspections and surveys.** This element aims to research technical and operational aspects related to autonomous runway inspections and surveys (e.g. laser scans, cameras, drones) *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.

- **AI-based separation management coherent with safety nets.** The separation management function overlaps/interacts with other ATM functions (mainly trajectory management and collision avoidance). This may result in conflicting strategies and solutions from the different ATM layers, to be avoided in order to ensure smooth and safe operations. Increasing levels of automation in the separation management function may include the adoption of AI systems as providers of trajectory advisories and clearances that are compatible by design both with trajectory management (i.e. compatible with constraints such as Controlled Time of Arrival - CTA) and with downstream safety nets. In other words, the resulting advisories would always be compatible with short-term conflict alert and traffic collision avoidance system logics. The gains associated with this approach, as well as the potential problems, would need to be evaluated, especially with regard to human interaction and acceptability by all actors *(R&I need: integration of safety nets (ground and airborne) into the separation management function)*.

2.1.4.1.2 Topic HORIZON-SESAR-2022-DES-ER1-WA1-2: Fundamental science and outreach for capacity on demand and dynamic airspace

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Capacity.** Project results are expected to contribute to capacity by identifying different sector volumes for complexity detection and resolution, while balancing workloads and optimising the use of resources. In addition, increased use of middle airspace (approximately between 15 000 ft and 25 000 ft) is expected to have a positive impact on capacity.
- **Operational efficiency.** Project results are expected to improve operational efficiency in terms of human performance and the resilience of the staff involved (e.g. ATCOs) to new working methods generated as a result of new/different task allocation strategies.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the capacity on demand and dynamic airspace flagship.

- **Human performance challenges in an ATM environment with higher levels of automation.** The ATM system can be seen as a joint human–machine cognitive system deriving from an integrated design that optimises the collaboration of actors with a view to improving system performance *(R&I need: on-demand ATS)*. The research will address:
  - human performance aspects related to higher levels of automation (e.g. stress, lack of attention, deskilling, complacency), and resilience by, for example, developing new approaches to determining suitable task allocation strategies enabling cooperation between ATCOs and/or other ATM actors and automation;

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  - the development of methods to enable automation to adapt to changes in the environment, such as changes in the behaviour of actors (e.g. modification of operational procedures), the entrance of new actors, and unforeseen traffic or weather situations/disruptions;
  - the development and assessment of suitable ML methods for ATM automation that are able to predict which information needs to be provided to enable the human operator to cooperatively work together with the automation;
  - new training requirements and programmes for ATCOs and other ATM personnel that take into account the implications of the expected future role of the human and the introduction of new support tools;
  - the use of psychophysiological measurements (e.g. neurometrics or the detection of facial expressions) for applications such as stress management systems, fatigue declaration, new training techniques and adaptive automation;
  - the privacy and acceptability aspects of the proposed solutions.
- **Legal and regulatory challenges in an ATM environment with higher levels of automation.** This element covers the challenges related to the means of approval/certification of novel ATM-related airborne and ground systems that enable higher levels of automation (in particular those systems based on ML techniques) by considering both legal and regulatory aspects (including privacy), along with technical aspects (e.g. architecture, system performance, reliability). In addition, potential changes to ATCOs' licences and training will be assessed, including with regard to the use of conflict detection and resolution support tools by ATCOs in order to ensure capacity growth, in contrast with the trend towards creating smaller sectors where capacity benefits reach a finite limit *(R&I need: on-demand ATS)*.
- **Increasing the use of middle airspace.** This element addresses the potential business case for increasing the use of middle airspace (approximately between 15 000 ft and 25 000 ft) by jet engine aircraft and the trade-offs between increased capacity (and reduced delays) through the provision of ATFM slots for flights in middle airspace and increased fuel consumption and environmental impact *(R&I need: on-demand ATSs)*.
- **Integration of air vehicles and personal air vehicles.** In the future, new UAVs and personal air vehicles will fly long range and at higher altitudes to feed airports. This research will investigate the necessary seamless integration of those personal air vehicles into a more automated ATM *(R&I need: on-demand ATS)*.
- **Models and theories of behaviour change.** An active role for the human factor in system design will be vital to support the transition from the tactical involvement of controllers to management of traffic "by exception". Research is needed to understand and manage the impact of system changes on human performance and workload in the long term. Readiness to change, barriers to change and likelihood of relapse should be addressed in system design, monitoring and improvement over the long term. Both models of behaviours and behavioural change theories should be investigated as diagnostic tools to explain and predict specific behaviours. Furthermore, resilience in handling abnormal situations should be addressed, in order to understand how this resilience can be maintained with reduced human involvement *(R&I need: on-demand ATS)*.

2.1.4.1.3 Topic HORIZON-SESAR-2022-DES-ER1-WA1-3: Fundamental science and outreach for U-space and urban air mobility

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that the proposed solutions would have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the U-space and UAM flagship.

- **Development of methodologies for environmental impact assessment of U-space operations.** This research will help in developing methodologies and metrics for environmental impact assessment (i.e. in relation to emissions, noise and local air quality) of U-space operations *(R&I need: U-space social acceptance aspects)*.
- **Evolution of ATM.** This element will explore whether U-space can be an accelerator of the ATM innovation life cycle, facilitating faster, lower-risk adoption of new technologies or approaches (automation, AI, internet of things (IoT), cloud, etc.). This could include, for example, the use of U-space communication solutions for air–ground communications on the airport surface (to free up the VHF spectrum for use in the air), adaptation of U-space automation concepts to manned aviation (e.g. advanced automation). In terms of the evolution of ATM, the aim will be to exploit the potential use of U-space technologies and concepts for manned aviation, with a focus on exploring the potential applicability of advanced U-space services to uncontrolled airspace, in particular Class G airspace. Applications to HAOs are also be within the scope of this element (*R&I need: transfer of U-space automation technology to ATM)*.

2.1.4.1.4 Topic HORIZON-SESAR-2022-DES-ER1-WA1-4: Fundamental science and outreach for virtualisation and cybersecure data-sharing

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Cost-efficiency.** Project results are expected to report on the potential advantages deriving from the sharing of space-based services for aviation applications. In addition, the cost impact of investment in empowered data storage for big data exploitation at NM level will be included in the analysis of the cost-effectiveness of the proposed solutions.

- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the virtualisation and cybersecure data-sharing flagship.

- **Quantum computing in ATM.** Quantum computing is likely to be able to break any current encryption method; therefore, a need for new security measures is anticipated. This research element will investigate the impact of quantum computing on future security needs in ATM *(R&I need: future data-sharing service delivery model)*.
- **Space-based CNS services.** The provision of CNS services using space-based technology will be researched. The purpose is to determine the effectiveness of space-based CNS services (e.g. automatic dependent surveillance broadcast (ADS-B), LDACS) in fulfilling the requirements of ATC operations for upper and lower routes, and their potential implementation and use at regional level. The research should refer to the ICAO GANP and use the aviation system block upgrade methodology *(R&I need: infrastructure as a service)*.
- **Digital voice.** Communication services are moving towards an approach based on the Internet Protocol (IP). There is a need to further investigate how the dynamic allocation of IP connections may reduce the need for VHF channels on the ground side and the need for the airborne side to switch frequencies several times during the flight *(R&I need: infrastructure as a service)*.
- **Hardening the ATC systems.** This element covers the use of AI for systems hardening in ATC: using AI-based penetration testing to identify vulnerabilities during the development, deployment and industrialisation phase of new systems *(R&I need: infrastructure as a service)*.
- **Enhanced techniques to empower NM operations.** This element covers improving data structure and data storage to empower big data exploitation and analytics to enhance NM strategic operations *(R&I need: free flow of data among trusted users across borders)*.
- **Application of business intelligence to network organisation.** This element aims to investigate how business intelligence strategies and technologies can be applied to improving the efficiency, stability and resilience of the network through data analysis of business information *(R&I need: free flow of data among trusted users across borders)*.
- **Identification and resolution of new (cyber)threats.** The evolving ATM scenario, with digital infrastructures, platforms and service provision becoming closely interconnected, will generate emerging cyberthreats, mostly linked to a very high number of connected devices and to data-sharing. This situation will require the identification (and resolution) of new cyberthreats, which is the aim of this research element *(R&I need: cyber-resilience)*.

- **Nurturing a (cyber)security culture.** This research element involves building knowledge and awareness of cybersecurity issues among humans using the technology. There is a need for the ATM system to become cyber-resilient, and investments in humans, as the users of the system, are needed. Humans are the easiest entry point for a cyberattack, and a more cyberaware culture is sorely needed. *(R&I need: cyber-resilience)*.
- **Conducting remote simulations/validations.** This element focuses on remote simulations as a means of boosting participant numbers by being location and time-zone independent and allowing for a more flexible and iterative design process, especially for design evaluation in the lower maturity phases of system development. As this area is in the very early stages of development, research should determine how its potential can be explored, so that, for example, the problem of a shortage of participants can be circumvented, while contributing to the availability of a wider range of experts globally. With possible reductions in demand for mobility and in flexibility in both time and space due to post-pandemic effects, this solution could provide both methodological and organisational benefits to the ATM and research communities. Aspects such as cultural/local ATM operational differences should also be studied, and more complex network effects analysed by enabling cloud-based remote human-in-the-loop multisite simulations, in a direction which may have additional synergies with that of ATM virtualisation. Technical and operational challenges related to cloud-based distributed simulations, especially in the case of human-in-the-loop experimentation, should be addressed in relation to the need to temporally synchronise the entire experiment and associated events and interventions, align all actors' views, etc. This challenge becomes even more difficult when trying to integrate legacy systems, which is another aspect that the research is expected to investigate from operational and technical points of view. *(R&I need: scalability and resilience)*.

2.1.4.1.5 Topic HORIZON-SESAR-2022-DES-ER1-WA1-5: Fundamental science and outreach for multimodality and passenger experience

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that the proposed solutions would have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint.
- **Capacity.** Project results are expected to contribute to capacity through real-time multimodal passenger constraint information that, when shared at network level, will help to reduce, for example, departure delay.
- **Passenger experience.** Project results are expected to demonstrate the viability of the integration of airports as multimodal nodes into the ATM network to enable interoperability between aviation and other modes of transport.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the multimodality and passenger experience flagship.

- **Multimodal airport.** This research aims to evaluate the potential impact of and help in designing new mobility solutions' (e.g. shared mobility). It should cover airport access, include an analysis of the use of connected and autonomous vehicles to access the airport (including studying the trade-offs in terms of the environment, door-to-door travel time, etc.), and examine the addition of UAM to intermodal solutions for airport access (e.g. can UAM help to enlarge an airport's catchment area?) *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.
- **UAM impact on multimodality.** This element covers research on methods and tools for the evaluation of the impact of UAM on intermodal solutions, including a demand study on UAM services, both passenger and freight, integrated into the multimodal transport chain. The design of intermodal solutions should leverage UAM to connect different airports in the same urban area (i.e. each airport would act as a terminal of the bigger airport) *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.
- **Multimodality and environment.** Environmental aspects will be a major driving factor in shaping the future (air) transport sector. There is a need to investigate the complementarity/substitutability of different modes of transport for certain distance segments: what the role of air transport will be, how future networks will change (e.g. in terms of the distribution of air traffic over different distance segments), how airline fleet composition will change and effects on airport operations. How can better integration of air transport with other modes of transport contribute to reducing the environmental impact of the door-to-door journey? *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.
- **Understanding passenger expectations.** Understanding passenger expectations (with regard to origin–destination, travel time, comfort, ecological impact and reliability) is a continuous activity linked to the flexibility/changes over time in demand for modes of transport. How can aviation monitor passenger expectations to improve its offer? How will changing passenger preferences shape the future multimodal transport system (e.g. airport products and services and the airport as a multimodal node) *(R&I need: passenger experience at the airport)*.
- **Anticipating disruptions.** This element covers research on methods for predicting disruption in support of proactive mitigation and on suitable management and recovery mechanisms *(R&I need: an integrated transport network performance cockpit)*.

2.1.4.1.6 *Topic HORIZON-SESAR-2022-DES-ER1-WA1-6: Fundamental science and outreach for the aviation Green Deal*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to contribute to the achievement of the objectives of a 55 % reduction in greenhouse gas emissions by 2030 and net-zero greenhouse gas emissions by 2050, from a gate-to-gate perspective, by introducing new concepts enabling proper modelling of non-CO_2 emissions and their impact on optimum green trajectories, taking into account the expected interoperability with new entrants (i.e. U-space flights).

- **Capacity.** Project results are expected to contribute also to the issue of sector capacity by taking into account the same new entrants (e.g. U-space flights).

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the aviation Green Deal flagship.

- **Atmospheric physics for aviation (non-CO_2).** This element covers research to increase the body of knowledge on the physics of the atmosphere, to better understand the impact on global warming of non-CO_2 emissions (NO_x, SO_x, H_2O, particulate matter, etc.), including contrails and aviation-induced cloudiness. It should aim in particular to reduce the uncertainty associated with the radiative forcing effects of aviation emissions identified in the 2020 European Commission report on the non-CO_2 impacts of aviation ([32]). Close coordination with EASA is expected, to ensure complementarity and consistency with EASA activities *(R&I need: non-CO_2 impacts of aviation)*.
- **Atmospheric physics for aviation (extreme weather events).** This element focuses on climate resilience and adaptation, as it aims to increase the body of knowledge on the physics of the atmosphere, to make it possible to better predict extreme weather events that may impact aircraft operations, and in particular cause airport closures or significant reductions in airport capacity (with knock-on effects on the network). The research should in particular consider the challenges for accurate prediction that may result from changes to weather patterns arising from global warming in the short to medium term (*R&I need: accelerating decarbonisation through operational and business incentivisation)*.
- **Comparative study on potential metrics to be adopted in the ATM domain to aggregate non-CO_2 and CO_2 impacts on climate change.** The study should cover, for example, GWP 100, ATR 20, ATR 50, ATR 100 and alternative metrics, taking as a starting point the options outlined in the 2020 European Commission report on the non-CO_2 impacts of aviation. The project should start with a review of the state of the art of environmental metrics and engage with all relevant stakeholders in order to provide insights into the pros and cons of each potential metric, with the aim of formulating informed recommendations for the way forward, including the identification of additional research needs if applicable. This research should consider how metrics can be used in different contexts, for example for operational decision-making in the pre-tactical and tactical phases of ATFM, operational decision-making in real time by ATC, post-operations analysis and environmental performance monitoring at network level. Close coordination with EASA is expected, to ensure complementarity and consistency with EASA activities *(R&I need: non-CO_2 impacts of aviation)*.

([32]) https://www.easa.europa.eu/document-library/research-reports/report-commission-european-parliament-and-council

- **Development of the environmental performance monitoring toolkit to include new entrants.** This element covers the expansion of the ATM aircraft performance models (on emissions and noise) to include new entrants and new aircraft types/fuels. It involves research into the impact on the environment of new fuels and/or new aircraft types (hydrogen, electric, sustainable aviation fuels, new hyper-/supersonic aircraft (with consideration of sonic booms)), including the development of new models to assess the impact that ATM operational changes may have when these aircraft are introduced into the traffic mix. It should also include the development of methodologies to assess the environmental and societal impact of U-space-enabled drone operations, including in particular the identification of all potential impacts (e.g. visual pollution, noise over populated areas, intrusion into privacy, risks to wildlife (migrating birds, nesting areas, etc.)) *(R&I need: impact of new entrants)*.

2.1.4.1.7 <u>*Topic HORIZON-SESAR-2022-DES-ER1-WA1-7: Fundamental science and outreach for AI for aviation*</u>

<u>*Expected outcomes*</u>

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that the proposed solutions would have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint.
- **Capacity.** Project results are expected to contribute to capacity by addressing the management of airspace in abnormal, disrupted situations.
- **Operational efficiency.** Project results are expected to demonstrate that the synchronisation and predictability of the ATM system will increase.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

<u>*Scope*</u>

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the AI for aviation flagship.

- **Management of abnormal situations.** AI/ML have great potential for predictions/forecasts under normal circumstances, but research is needed to investigate the further evolution that will be needed if they are to be used in the management of abnormal situations: a prescriptive approach will be required to monitor the reality and specify precursors indicating possible deviations from what is expected *(R&I need: AI for prescriptive aviation)*.
- **Human-centric AI.** Aviation will need to ensure a human-centric approach, as described in the EASA AI roadmap. Humans should understand what the systems are doing and also maintain the right level of situational awareness (i.e. to understand the situation

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well enough to enable human–machine cooperation) *(R&I need: human–AI collaboration: digital assistants)*.

- **Air and ground synchronisation.** AI-powered systems are expected to be integrated into ground and cockpit systems, enhancing communication for trajectory management and much more. The scope of this research includes the identification of innovative applications / AI-based solutions that could improve such synchronisation *(R&I need: human–AI collaboration: digital assistants)*.
- **AI for higher automation.** This element covers the development of an AI-powered cloud-based infrastructure and services (supporting higher levels of automation). In addition, the aim is to develop automation of ATM processes in which analysis and prediction are particularly likely to benefit from AI, and to develop AI-powered ATM environment requirements, infrastructure, and common regulation and certification guidelines *(R&I need: AI improved datasets for better airborne operations)*.
- **Datasets.** Datasets are essential for the development of AI-based applications. Starting from an assessment of the state of the art, this element involves researching new ideas to generate and enable the automation of aviation-specific datasets from a large variety of on-board and ground communications across the network, which could then enable a broad range of AI-based applications for aviation. The research will also cover legal (e.g. liability), financial and regulatory aspects and will take into account the issue of how complete the datasets need to be to meet ATM requirements *(R&I need: AI improved datasets for better airborne operations)*.
- **Interoperability of ATM systems with different levels of automation.** Although there is consensus on increasing automation levels to improve the efficiency of ATM systems and reduce costs, it is clear that not all functions will be at the same level of automation, and collaborating control centres and other stakeholders may have different levels of implementation of highly automated systems, even for the same functions. A methodology to produce automation strategies (roadmaps) providing a safe stepwise route to the full implementation of high automation levels is therefore needed *(R&I need: trustworthy AI powered ATM environment)*.
- **Cyberthreat intelligence services in aviation/ATM.** The use of techniques based on ML to support cyberthreat detection and mitigation is quite widespread in the state of the art of various industries (e.g. internet services, e-commerce, content delivery networks); observation of anomalous traffic patterns or transactions enables the detection of cyberattacks. The transfer of these methods to ATM is not straightforward and, given the current tendency in ATM to enhance information-sharing to implement machine-to-machine automated functions (e.g. through SWIM implementation, increased bandwidth air–ground communications) while maintaining legacy systems built without any proper security policy, research in this area is needed *(R&I need: trustworthy AI-powered ATM environment)*.

2.1.4.1.8 Topic HORIZON-SESAR-2022-DES-ER1-WA1-8: Fundamental science and outreach for civil–military interoperability and coordination

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Civil–military coordination.** Project results are expected to improve civil–military coordination at NM level, with shareable data on mission trajectories for better traffic prediction and airspace information exchange.
- **Security.** While ensuring better coordination, project results will also ensure that the new data formats and information exchange services maintain at least the current level of confidentiality, integrity and availability of information.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the civil–military interoperability and coordination flagship.

- **Enhancing civil–military operations.** Based on a survey of the existing procedures and services, this element will aim to identify new challenges related to the development of CDM processes for improved civil–military coordination, covering both manned and unmanned military assets. The research will investigate procedures, data formats (including the necessary levels of cybersecurity and data protection), dual-use technologies and information exchange services. An assessment of the relevant performance measurements will also carried out *(R&I need: access to airspace and SWIM)*.
- **Access to airspace.** In order to make optimal use of ATM resources shared with civil stakeholders, military access to airspace depends on the requirements and priorities of each mission. In that regard, high-level civil–military ATM interoperability is fundamental, and this can be achieved through civil–military CDM supported by common procedures, data formats and underlying information exchange services. New systems and procedures should be flexible enough to adapt to different operational scenarios and needs, and ensure optimal separation management (e.g. dynamic mobile area – DMA – type 3) taking into account different and coexistent CNS air and ground capabilities. This is a precondition for accommodating civil and military operations in the same airspace *(R&I need: access to airspace and SWIM)*.
- **Performance management.** Environmental sustainability, cost-efficiency and delays resulting from inefficient use of available capacity are concerns that all aviation stakeholders are responsible for addressing. The complex interdependencies between civil and military stakeholders need to be examined to enable appropriate performance measurement in a spirit of balanced consideration between commercial needs and security and defence requirements *(R&I need: performance)*.

2.1.4.2 *Work Area 2: ATM application-oriented research (research and innovation actions)*

Specific conditions for WA2	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 2.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 10.00 million

Type of actions	Research and innovation action (RIA)
Legal and financial set-up of the grant agreement	Grants awarded under this work area will have to submit the following deliverables: • Exploratory research report (ERP) • Exploratory research report (ERR) • Functional requirements document (FRD) • Operational services and environment description (OSED) • Economic evaluation (ECO-EVAL) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated)
Other requirements	The maximum project duration is 30 months, including a 6-month period at the end of the project life cycle to undertake communications, dissemination and exploitation activities in relation to the research results.

2.1.4.2.1 *Topic HORIZON-SESAR-2022-DES-ER1-WA2-1: ATM application-oriented research for connected and automated ATM*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that the proposed solutions would have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint.
- **Capacity.** Project results are expected to contribute to capacity by enhancing the management of separation minima, both for en-route airspace and the TMA, and the provision of meteorological information. At airport level, the solutions will enhance the calculation of arrival runway occupancy times and the resilience of runway throughput to meteorological disruptions, enhance departure queue management, improve visual separation procedures for the aerodrome circuit and support fully automated airport operations through improved predictability.
- **Cost-efficiency.** Project results are expected to justify the investment costs related to the adoption of automated technologies and tools.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system, with higher levels of automation, especially through the identification of negotiation-based resolutions at conflict resolution and collision avoidance levels, safety nets for new separation modes and improved approach procedures into secondary airports in low-visibility conditions.

- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the connected and automated ATM flagship.

- **Evolution of flight-rule concepts, separation management service concepts and airspace classification.** This element covers the potential evolution of responsibility for separation provision in an environment where advanced detect and avoid (DAA) and electronic conspicuity systems are fitted to all participating traffic. Research should cover, individually and collectively, the role of the separator and the mode of separation provision; the need for and possible updates to or renewal of the airspace classification system; the definition and potential renewal of flight rules for manned and unmanned aircraft; and a potential review/qualification of the need for visual flight rules (VFR) flights to remain in visual meteorological conditions, including the need to remain clear of cloud, given the existence of advanced electronic systems that replace and/or augment the performance of the human eye. The research must assess the impact on all current airspace users, including main airlines, business aviation, general aviation, sports aviation and military aviation, as well as considering the impact on new entrants (both drones flying low and manned or unmanned aircraft flying at high altitude) *(R&I need: advanced separation management (U-space integration and new separation modes))*.
- Use of advanced meteorological information and capabilities (*R&I need: advanced separation management (U-space integration and new separation modes))*. This research covers the needs to:
  - incorporate ensemble weather information into decision support tools that can be adapted for different ATM stakeholders;
  - produce very high-resolution, very short-range weather forecasts using numerical weather prediction models and observational data assimilation;
  - share very short-range weather forecasts based on Aircraft Meteorological Data Relay and observational data assimilation (e.g. predicted wind, wind shear) during the approach and landing phases. The research also covers the novel avionics and flight crew procedures required to use this information.
- **Enhanced arrival/departure runway occupancy time.** The scope includes enhancing runway occupancy time calculation, through efficient runway turn-off and a combination of existing optimised braking-to-vacate solutions, at pre-selected runway exits, and new applications to assist the flight crew in achieving efficient turn-off to the point where the aircraft has left the protected area of the runway. Similarly, the research should also enhance the departure runway occupancy time calculation, through more efficient line-up and take-off. The research should address potential on-board applications to assist the flight crew of a departing aircraft to achieve more efficient (fast, accurate, reliable and safe) line-up and take-off *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools);*

- **Optimised and resilient runway throughput.** This element investigates how to enhance MET resilience in low-visibility conditions and during thunderstorms, and considers the need for parallel or near-parallel instrument runway separations in the light of advanced technology and surveillance capabilities integrated with coupled AMAN / departure management (DMAN) and TBS toolkits for both arrivals and departures *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Adaptation of ground and airborne safety nets to new separation modes.** This element covers advanced separation management that will require close conformance monitoring of the negotiated and authorised flight trajectories throughout the execution phase, so that operations are not disturbed by unnecessary resolution advisories, in particular if lower separation minima are introduced/considered. Consideration of the level of independence of safety nets from other aspects of control will be critical, as the levels of autonomy automation of detection, classification, resolution and monitoring of conflicting profiles in the planning and tactical phases of ATM will significantly increase *(R&I needs: integration of safety nets (ground and airborne) with the separation management function)*.
- **TBO machine-to-machine flight deck to ATC negotiation.** This element covers machine-to-machine negotiation-based conflict resolution. The development of mechanisms and tools for creating negotiation-based resolutions at conflict resolution and collision avoidance levels (e.g. what-if extended projected profile (EPP)-based tools, or ATC offering a choice to the FMS of two potential cruising levels) will be addressed. This is a flight deck to ATC solution (i.e. with airline operations centre involvement) *(R&I need: advanced separation management (U-space integration and new separation modes))*.
- **Space-based multilateration.** This element covers space-based multilateration through ranging by satellites already used for space-based VHF or ADS-B systems, with preference given to those used for space-based ADS-B, as this could serve to cross-check the GNSS position acquired through ADS-B (in the same way that Mode S radar has a double check). The development of an integrity parameter for space-based ADS-B downlink to ground system should also be covered. *(R&I need: enabling the deployment of a performance-based CNS service offer)*,
- **Arbitrary levels.** This research is aimed at enabling aircraft to fly at any arbitrary flight level, as optimised by aircraft performance, weight and atmospheric conditions. Even/odd cruise level assignment should be based on traffic supply, rather than on the semi-circular rule (also known as the hemispheric rule). The results should enable the use of all flight levels in the European one-way 'trunk routes' concept *(R&I need: advanced separation management (U-space integration and new separation modes)*.
- **Additional extended AMAN capabilities.** The scope includes investigating AMAN capabilities, focusing on the transfer of the predicted arrival holding times from the TMA to the upstream airspace to reduce holding, the use of ML for the refinement of AMAN algorithms, etc. *(R&I need: intelligent queue management)*.
- **Enhanced departure queue management.** This element covers enhancing departure queue management through further automation and exchange of highly accurate trajectory information between all actors (i.e. airports, ANSPs and aircraft operators). ML and AI should be used to monitor differences between DMAN sequences and their implementation, in order to improve DMAN sequencing algorithms *(R&I need: intelligent queue management)*.

- **Data-sharing between airport collaborative decision-making (A-CDM) parties, arrival and departure managers, and TBS tools.** This element focuses on data-sharing between A-CDM parties, arrival and departure managers, and TBS tools, to allow the dynamic optimisation of runway use based on prevailing operational needs *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Digital coupled AMAN–DMAN function.** This element is about enhancing coupled AMAN–DMAN functions using ML and AI techniques identify the most appropriate departing aircraft to make use of an arrival gap. This information is to be shared with airport systems to ensure that the departing aircraft is loaded in a timely manner and taxies to the right place at the right time to be ready to take off *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Improved visual separation procedures for the aerodrome circuit.** This element is about reviewing current minimum separation standards/procedures in the airport environment, to meet a minimum acceptable safety level (i.e. moving away from pre-determined separation standards). The research should look at improved visual separation procedures for the aerodrome circuit, for example using a combination of surveillance and system support, targeting busy airports with high VFR traffic, in particular those that need to integrate IFR and VFR traffic (e.g. Charleroi airport) *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Application of physiological measurements to ATCOs.** The aim is to research the application of physiological measurements to ATCOs (e.g. measuring brain waves to assess the level of attention, using speech recognition combined with physiological measurements to monitor stress, correlation of eye-movement patterns with the occurrence of events that are potentially safety relevant) *(R&I need: role of the human)*.
- **Trajectory broker in all phases of ATFM operation.** This element covers the trajectory broker layer, including research on how to make better use of available capacity in all phases of ATFM operation (long-term, medium-term, short-term and execution phases) and in all areas (airport, TMA, en route), addressing technical aspects but also considering the necessary regulatory/organisational changes *(R&I need: network-wide synchronisation of trajectory information)*.

2.1.4.2.2 Topic HORIZON-SESAR-2022-DES-ER1-WA2-2: ATM application-oriented research for air–ground integration and autonomy

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Capacity.** Project results are expected to contribute to capacity by enhancing the management of separation minima, both for en-route airspace and the TMA, and the provision of meteorological information. At airport level, the solutions will enhance the calculation of arrival runway occupancy times and the resilience of runway throughput to meteorological disruptions, enhance departure queue management, improve visual separation procedures for the aerodrome circuit and support fully automated airport operations through improved predictability.

- **Cost-efficiency.** Project results are expected to demonstrate that, with new services supported by ground–ground and air–ground connectivity, cost-efficiency is expected to be improved.
- **Operational efficiency.** Project results are expected to contribute to the improvement of the operational efficiency thanks to advanced communication means and increased automation (e.g. machine-to-machine communication). In addition, trajectory management is expected to improve.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the air–ground integration and autonomy flagship.

- **Frequency management.** This research will investigate, from a gate-to-gate perspective, the automation of air–ground coordination to ensure the use of automatic link and frequency selection for communications by the pilot and ATC. This is expected also to support single-pilot and cross-border operations *(R&I need: enabling greater ground and airborne integration and wider performance)*.
- **Seamless connectivity between ground and aircraft via high-capacity networks.** This element covers seamless connectivity between ground and aircraft through the use of high-capacity networks (e.g. novel use of public infrastructure such as 5G for aviation purposes) to transmit ATS communications, virtual guidance, warnings and stop bars to aircraft on the airport surface *(R&I need: enabling greater ground and airborne integration and wider performance)*.
- **Machine-to-machine communication.** In addition to human-to-human communication, such as controller–pilot datalink communications (CPDLC), datalink will also support machine-to-machine communication. Technical and operational requirements, as well as use cases and initial validation, will be addressed in this research *(R&I need: integrated 4D trajectory automation in support of TBOs)*.
- **Advanced air–ground integration for general aviation.** This activity will ensure that access to all airspace classes remains open to general aviation in an equitable manner and at an affordable cost. as well as the leverage on-board technologies (potentially not certified) in order to guarantee better and safer flights for all general aviation users, including sports aviation. It may also include the development of a concept enabling VFR aircraft to share their intended plans in real time with ATC and/or U-space service providers through a low-cost non-certified EPP-like concept based on whatever application the general aviation pilot is using to plan his flight in real time. This solution would complement surveillance information and would result in a continually updated flight plan, which could be used to automatically change the destination airport, to ensure that general aviation pilots receive updated information if their plan changes and

to support search and rescue operations when no surveillance information is available. VFR pilots would retain at all times the same degree of flexibility in changing the plan as they have today *(R&I need: enabling greater ground and airborne integration and wider performance)*.

2.1.4.2.3 Topic HORIZON-SESAR-2022-DES-ER1-WA2-3: ATM application-oriented research for capacity on demand and dynamic airspace

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Capacity.** Project results are expected to contribute to capacity by introducing new digital services (e.g. enhanced network traffic prediction and shared complexity representation, improved demand–capacity balancing (DCB) processes, improved airline operations).
- **Cost-efficiency.** Project results are expected to improve the training process for ATCOs and their performance in highly automated environments, and thus their productivity.
- **Operational efficiency.** Project results are expected to improve predictions of the evolution of the network in terms, for example, of traffic flows, complexity assessment, calibration of airspace/sector capacity, to improve airspace users' (AUs') decision-making processes and the accuracy of short-term predictions of risk of propagation of disruption at network level.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the capacity on demand and dynamic airspace flagship.

- **Digital network services** *(R&I need: on-demand ATS)***.** This research will address:
  - the improvement of DCB by enhancing trajectory prediction, integrating uncertainty assessment, robust planning and cost-efficiency assessment at network level;
  - the integration of network and local tools used by AUs, airports and ANSPs (e.g. flow management position (FMP) and integrated network management and ATC planning (INAP)) in a rolling and dynamic process, including further automation support in the coordination of DCB actions from long-term to execution phases;
  - hotspot management using traffic monitoring values to meet various objectives (safety, rate optimisation, critical situations, etc.) and to identify and address different types of spots (regions of interest);
  - the use of modelling and operational data to understand typical resolutions to network planning and traffic management problems, with the aim of developing optimisation capabilities that are less human-centric.
- **Future digital network services** *(R&I need: on-demand ATS)***.** The research will address:

- ML to identify and exploit information patterns, and AI to identify and design new elementary basic sector volumes for complexity detection and resolution, while balancing workloads and optimising resources;
- the use of big data analysis, ML and digital-twin techniques to better plan the reactions of various actors (ATCOs, FMPs, AUs) to potential operational improvements based on emerging trends (e.g. incentives);
- innovative DCB resolution algorithms, for example using radically different algorithms from those currently in use or using alternative approaches;
- the use of new data sources (e.g. big data), ML algorithms (including neural networks), AI-based decision support tools, behavioural economics, improved market modelling, complexity science, etc., to support network operations (e.g. models and methods for improving demand, flow and complexity forecasting and resolution);
- the use of big data and ML to identify best practices regarding regulation strategies for particular traffic-load patterns based on historical data, and the development of optimised strategies for the most frequent traffic-load situations in the European air traffic flow and capacity management (ATFCM) network.

- **Digital airline operations.** This element will cover improvements to airline operations based on the use of digital technologies (e.g. big data, ML algorithms, AI, IoT, behavioural economics, improved market modelling, complexity science, etc.) to support airline decision-making processes in disruption scenarios; the integration of airline operations into the network; collaboration between flight operations centres (FOCs), the network management function and ATC; and the better consideration of airspace users' preferences in DCB and sequencing processes. The use of new data sources (big data), ML algorithms, AI-based decision support tools, etc., to support airline decision-making in disruption scenarios is expected to increase the resilience of the system *(R&I need: on-demand ATS)*.
- **New trajectory pricing schemes.** This element will cover the development and initial validation of new trajectory pricing schemes to support more flexible distribution of the demand *(R&I need: on-demand ATS)*.
- **Flexible flight level (FL) structure.** The aim of the research is to support the NM's calculation of the optimal division of flight level structure for specific periods of time, develop processes for agreement with ATSUs and create tools to integrate flexible division of flight levels into ATM systems *(R&I need: on-demand ATS)*.
- **Improved prediction of network evolution.** The research is about the use of ML techniques for the identification and prediction of major traffic flows, complexity assessment, calibration of airspace/sector capacity, flight delays, estimated arrival and overflight times, etc., with the objective of reducing the network's capacity buffers and improving the handling of AU priorities/preferences and disruption management. In addition, the improvement of ATFM processes through the inclusion of convective weather information should be addressed *(R&I need: ATM continuity of service despite disruption)*.
- **Improved decision-making processes among AUs.** Enriched DCB information and enhanced what-ifs available to improve AUs' decision-making processes when planning or replanning trajectories should be addressed through this element. Enriched DCB information will encompass DCB constraints/measures, information such as ATFCM

regulations / calculated take-off time (CTOT) / short-term ATFCM measures (STAM), and additional DCB information such as hotspots and congestion level indicators *(R&I need: future data services and applications for airport and network)*.

- **Full integration and connectivity of ATM operations.** This research will investigate the integration of connectivity into the loop of ATM operations and the new datasets available through A-CDM, UDPP, airport operations plan (AOP) / the network operations plan (NOP), target time over/arrival and extended AMAN demand in order to further develop the rules for ATFCM and queuing priorities *(R&I need: future data services and applications for airport and network)*.
- **New operational and social indicators for airspace users.** The scope of this element includes the definition and validation of new operational and social indicators for airspace users. These should be integrated into the overall R&I performance framework, building on the results of SESAR validations, identifying gaps in the required knowledge and determining the steps to be taken from research to pre-industrialisation and deployment (with full integration of operational processes and systems' interoperability) *(R&I need: future data services and applications for airport and network)*.
- **Short-term prediction of risk of propagation of problems through the network and identification of cost-effective solutions.** This element focuses on the availability of an online platform to assess the risk of expansion of local emergencies to other regions or countries in the world through the air transport network. The platform will also identify the components of the network (airports, routes, airlines, etc.) that could have a major impact on the risk of expansion of an emergency and the reasons why they could do so. The platform will support the assessment of solutions that could be implemented to prevent the expansion of an emergency at different scales (airport- or aircraft-related measures and measures at regional or country level). A multi-objective performance framework will make it possible to analyse each solution from various perspectives: on the one hand, emergency-related metrics will quantify the effectiveness of the solution and the resilience to changes in the evolution of the emergency around the world, while, on the other hand ATM-related metrics will quantify the impact on capacity, efficiency and the environment. Both perspectives will be combined in cost-related metrics that will determine the cost of implementing each solution, and also the economic implications for the air transport sector. This approach will facilitate joint decision-making among airlines, airports, regions and countries, resulting in decisions that are more efficient and less aggressive for the air transport sector than simply closing airports or airspaces *(R&I need: ATM continuity of service despite disruption)*.
- **Formation of contingency plans.** This research will help in developing and integrating ANSP contingency plans for emergency operations in the face of recurring and sudden events (weather and other hazards), as well as potential responses from operators *(R&I need: ATM continuity of service despite disruption)*.

2.1.4.2.4 Topic HORIZON-SESAR-2022-DES-ER1-WA2-4: ATM application-oriented research for U-space and urban air mobility

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate that there the proposed solutions would have no negative impact on the environment (e.g. in terms of noise) or on potential improvement of the aviation environmental footprint.
- **Passenger experience.** Project results are expected to improve citizens' well-being through the validation of operational and technical requirements linked to UAM, while protecting their privacy and contributing to the social acceptance of new entrants.
- **Capacity.** Project results are expected to demonstrate that capacity would not be affected by the development of new U-space services or the validation of operational and technical requirements. In addition, the development of indicators and metrics linked to U-space should help to demonstrate that there would be no negative impact on capacity.
- **Cost-efficiency.** Project results are expected to demonstrate that U-space will not negatively affect the cost of providing ATM services. The definition of specific cost-efficiency indicators and metrics for U-space will focus on this aspect.
- **Operational efficiency.** Project results are expected to demonstrate that the requested validation of operational and technical requirements for UAM will not reduce the operational efficiency of the current ATM system.
- **Safety.** Project results are expected to define a safety framework for U-space, including metrics and indicators, able to demonstrate that at least the same level of safety as the current ATM system would be maintained.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

<u>*Scope*</u>

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the U-space and UAM flagship.

- **Validation of UAM operational and technical requirements.** This research will look at the development and validation of the operational concept of UAM, looking at the additional requirements for the urban environment (compared with the U-space requirements for non-urban airspace). In addition, the delta from the U-space in terms of infrastructure and CNS challenges in the urban airspace should be addressed *(R&I need: enable UAM)*.
- **Measures to protect the privacy of the European citizen in a U-space environment.** This research is aimed at identifying, collecting and reviewing requirements to protect the privacy of European citizens in a U-space environment, and developing/adapting U-space services so that they are fulfilled *(R&I need: U-space social acceptance aspects)*.
- **Development of a U-space performance framework.** This research will look into options for the development of a performance framework for U-space. The research will identify the relevant KPAs for U-space and develop a set of performance indicators to measure the performance of U-space services. In addition to looking at the KPAs of operational efficiency and cost-efficiency, it is expected that the research will explore how equity and fairness apply to U-space *(R&I need: U-space performance framework)*.

- **Development of a U-space safety framework.** This element covers the need for new safety modelling and assessment methodologies applicable to U-space. Tools are required to analyse and quantify the level of safety of U-space operations involving high levels of automation and autonomy, where multiple actors automatically make complex, interrelated decisions under conditions of uncertainty (e.g. weather-related uncertainty). Research is needed to ensure that the distributed decision-making protocols implemented in U-space achieve the required level of safety while catering for differing levels of experience of participants. Examples of approaches that could be leveraged for this purpose include greater use of simulation and ML applications such as stress-testing. As in the case of manned aviation, there may be a need to have different frameworks for R&D and for operations (search and rescue versus safety risk management) *(R&I need: U-space safety assurance).*
- **Introduction of environmental impact assessment and dialogues in U-space flight plan approval processes.** This element covers the development of a service to provide an environmental impact assessment for each individual flight plan as part of the U-space flight plan approval process. The service could include what-if/what-else dialogues and suggest options to reduce environmental impact (e.g. alternative routes or times, maximum speeds, noise abatement procedures, etc.) *(R&I need: develop advanced U-space services)*.

2.1.4.2.5 Topic HORIZON-SESAR-2022-DES-ER1-WA2-5: ATM application-oriented research for virtualisation and cybersecure data-sharing

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Capacity.** Project results are expected to demonstrate that capacity would not be affected by the development of new U-space services or the validation of operational and technical requirements. In addition, the development of indicators and metrics linked to U-space should help to demonstrate that there would be no negative impact on capacity.
- **Cost-efficiency.** Project results are expected to make a positive contribution to the cost-efficiency of the ATM system through, for example, the sharing of the same infrastructure among different ATM services, harmonised and rationalised refurbishment of legacy infrastructures, changes to route-charging and cost-recovery mechanisms.
- **Operational efficiency.** Project results are expected to demonstrate that the ATM workforce, such as ATCOs, ATSEPs and pilots, will maintain at least the same level of efficiency as currently, even when dealing with cyberattacks.
- **Safety.** Project results are expected to contribute to the improvement to the level of safety of both legacy and newly developed ATM services and systems, and to provide the necessary standardisation and regulatory framework.
- **Security.** Project results are expected to contribute to the improvement to the level of (cyber)security of both legacy and newly developed ATM services and systems, and to provide the necessary standardisation and regulatory framework.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the virtualisation and cybersecure data-sharing flagship.

- **Safety versus cybersecurity.** Safety and security are intricately intertwined. The research will identify use cases in which safety risk-mitigating measures and security risk-mitigating measures are in conflict and provide guidance on how to resolve such conflicts during the design phase. Examples may include time-consuming processes for systems certification (safety) versus fast processes for patch management (security), and open data exchange for surveillance, such as traffic collision avoidance systems and ADS-B (increased awareness), versus encrypted data exchange for surveillance (protection of data against abuse) *(R&I need: future data-sharing service delivery model)*.
- **New virtualisation business model.** Virtualisation (i.e. decoupling the provision of ATM data services from ATSs) is expected to enable a better offer of airspace capacity through collaboration between the NM and ATSUs. New and/or different business models could be identified and investigated, along with the possibility of having emerging new ATM players, which would foster competition in the sector. Examples of questions to be addressed in this element are ‘How will virtualisation impact the way ANSPs make implementation choices?’ and ‘How will the new ATM services be provided?’ *(R&I need: scalability and resilience)*.
- **Improved platform interoperability.** This research is about how to improve the sharing and exchange of ATM data via interoperable platforms to improve existing and new ATM services and processes, using both existing data exchange concepts (e.g. SWIM) and new ones. The research should consider the associated cyber-resilience aspects *(R&I need: free flow of data among trusted users across borders)*.
- **Regulatory frameworks for future ATM services.** This element will assess the need for new/updated legal and regulatory frameworks for the provision of ATM services in a service-oriented architecture environment. More specifically, operating expense and lower capital expense requirements should be addressed *(R&I need: regulations and standards)*.
- **Evolution of route-charging and cost-recovery mechanisms.** This element investigates how route-charging and cost-recovery mechanisms should evolve in order to move towards a service-oriented provision scheme that is supplier independent *(R&I need: regulations and standards)*.
- **Efficient application of standards.** This element covers the need for the efficient application of regulations, standards, procedures and guidelines addressing safety, privacy and cyber-resilience risks, which is a key element to protect ATM information and information systems. Therefore, it is necessary to further develop cyber-resilience regulations, standards, procedures and guidelines, which should be based on ones from other domains (e.g. blockchain) *(R&I need: regulations and standards)*.
- **ML and cybersecurity.** This research is aimed at investigating, from a cybersecurity perspective, issues relating to ML techniques for ATM applications, in particular what

the risks are, how to perform a risk assessment and what mitigating measures could be effective *(R&I need: cyber-resilience)*.

- **Beyond state-of-the-art cybersecurity standards and methods.** This element covers the development of advanced cybersecurity methods (science, technologies and processes), going beyond the state of the art and looking beyond the horizon to prepare the next generation of cybersecurity standards for aviation. The results should cover the training process for ATCOs, ATSEPs and pilots dealing with continually changing cyberthreats *(R&I need: cyber-resilience)*.

2.1.4.2.6 Topic HORIZON-SESAR-2022-DES-ER1-WA2-6: ATM application-oriented research for multimodality and passenger experience

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate the positive impact that the proposed solutions would have on the environment (i.e. in terms of emissions, noise and/or local air quality) by alleviating congestion at and around airports through better prediction of passenger flows (e.g. using multimodal decision-making tools, single ticketing, etc.), by supporting access to / egress from airports by environmentally friendly means, etc.
- **Passenger experience.** Project results are expected to improve the passenger experience by sharing data on air transport with travel service providers, thus helping passengers plan intermodal journeys that include air segments. This will also be achieved through appropriate analysis of traveller behaviour, modelling and simulation.
- **Capacity.** Project results are expected to contribute to capacity by providing methods for journey optimisation and personalisation of offers to passengers, especially in the event of disruption (e.g. enabling passengers to rebook and replan travel using the same or different means of transport).
- **Cost-efficiency.** Project results are expected to demonstrate that new data-sharing standards, together with a tailored multimodal performance scheme and governance, will allow new ‘as a service’ businesses, adding value for aviation within an integrated transport system.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the multimodality and passenger experience flagship.

- **Future airport business model.** This research is about how the airport business model of the future is expected to evolve in terms of adjustments to emerging/changing passenger requirements, airline business models and integrating new procedural requirements *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.

- **Multimodal governance.** This element covers the governance and standards to facilitate coordination between modes of transport in a multimodal environment; the need for regulation to ensure a level playing field for service providers, preventing market dominance or uncompetitive pricing from limited providers and not limiting market access for others; and multimodal trip pack creation and corresponding insurance. In addition, there is a need to investigate ensuring that security policies for air and other modes of transport (e.g. rail) are complementary, especially considering the importance of reducing administrative burdens *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.
- **Multimodal decision-making tools.** This research covers the development of decision support systems for intermodal solutions to manage systems at tactical and/or strategic level (e.g. collaborative optimisation of passenger or goods flows across a multimodal transport chain, optimal use of available capacity) *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.
- **Advanced techniques for passenger flow prediction.** This element is aimed at developing advanced predictive models to anticipate the evolution of an airport's passenger flows within the day of operations and assess the operational impact on both airport processes and the ground transport system, with the aim of enabling real-time CDM between airports and ground transport stakeholders and enhanced passenger information services *(R&I need: passenger experience at the airport)*.
- **Traveller behaviour analysis, modelling and simulation.** This element investigates the need for new/different big data sources for the analysis of multimodal travel behaviour (including requirements for integrated, private data management, so that all service providers can sell capacity into an integrated booking system but retain their own supply privacy), the need for better representation of multimodal trips in transport and traffic simulation models, the integration of commercially sensitive data from air and ground transport operators into passenger demand models (through, for example, federated ML models) and the impact of the shift from feeder flights to other modes of transport (environment, door-to-door time, better resource allocation, freeing up airport slots, etc.) *(R&I need: passenger experience at the airport)*.
- **Passenger travel behaviour and requirements.** This research covers the factors affecting passenger mode choice, especially the factors driving the decision to use a particular mode for different distance segments (e.g. air versus rail for short-haul traffic and the complementarity between them), preferences relating to the journey (travel time, comfort, price, CO_2 emissions) and how these preferences will affect future door-to-door journeys. In addition, passengers' journey planning has to be considered: how to improve the door-to-door options and information on multimodal travel for passengers (e.g. through offering one ticket for multimodal trips (single ticketing), mobility as a service tickets, one-stop shops, etc.) *(R&I need: passenger experience at the airport)*.
- **Integrated performance network.** This element covers the establishment of an overall transport network performance framework to improve passenger experience and planning, through improved collaboration between different modes of transport; improved integration of data and processes; specification of GDPR-compliant

requirements for the collection, analysis and exploitation of additional data. The aim is to create a pan-European database supporting journey optimisation and personalisation of offers to customers. The research will also address information for passengers during disruption (e.g. enabling passengers to rebook and replan during disruption by further developing existing tools); corresponding passenger rights information; and real-time, user-friendly, accessible and accurate information to improve the passenger experience before and during travel *(R&I need: an integrated transport network performance cockpit)*.

- **Multimodal performance scheme.** The aim is to develop a set of multimodal KPIs – based on the current single European sky performance scheme, ICAO, EU connectivity indicators and indicators used in other modes of transport – to allow the evaluation of the impact of innovative intermodal transport solutions on the quality, efficiency and resilience of the door-to-door passenger journey. Tactically, there is a need to move away from less meaningful passenger-centric metrics such as small average delays, instead producing better measures of significant disruption (e.g. longer delays, missed connections, denied boarding, cancellations) and integrating currently lacking metrics into the KPAs of flexibility and predictability, which remain important dimensions in travel choice decision-making and trade-offs for the passenger. A better understanding of passenger (dis)utility and passenger archetypes is required to deliver better service to the customer *(R&I need: an integrated transport network performance cockpit)*.

2.1.4.2.7 Topic HORIZON-SESAR-2022-DES-ER1-WA2-7: ATM application-oriented research for the aviation Green Deal

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to contribute to the achievement of the objectives of a 55 % reduction in greenhouse gas emissions by 2030 and net-zero greenhouse gas emissions by 2050, by maturing concepts enabling optimal and optimum green trajectories, thus reducing CO_2 and non CO_2 emissions, as well as contributing to new and up-to-date models to tackle emissions and noise and improve local air quality. In addition, the impact of new entrants and new aircraft types / fuels on the environment should be assessed.
- **Capacity.** Project results are expected to contribute to the issue of sector capacity through the identification of optimal and environmentally friendly flight trajectories, including for new entrants (e.g. U-space flights).
- **Safety.** Project results are expected to contribute to the integration and improved interoperability of manned aviation with drones, and also to the integration of HAOs, thus keeping the level of safety of operations at least at the same level as today.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the aviation green deal flagship.

- **Geometric altimetry.** In current operations, aircraft cruising at a constant barometric pressure need to climb/descend when flying across isobars, which in the case of a climb causes extra fuel-burn. This extra fuel-burn may be offset if, thanks to it, the aircraft stays at its optimum (or at least closer to optimum) pressure altitude / temperature for a long enough time, but otherwise fuel may be wasted. The use of barometric altimetry has been the only option since the advent of aviation, but a move to geometric altimetry is deemed possible today because aircraft are nowadays for the most part equipped with GNSS, and this trend is expected to grow in the future. There is a need to assess the potential environmental benefits of moving to geometric altimetry, considering not only the impact on aircraft that are at cruising level but also the other concepts that would be unlocked by it, for example reduced vertical separation minima (RVSM 2) and elimination of the wasted airspace allocated to the 'transition layer'. Research is also needed to develop an operational concept to move all aviation (en route and TMA, general aviation, airliners, civilian and military traffic, in all airspace classes) to geometric altimetry. Note that, in addition to the environmental benefits, the move to geometric altimetry is also expected to facilitate the approach and landing phases (e.g. no need to transition from barometric to geometric altimetry during the approach), which will have safety benefits. Geometric altimetry will also facilitate the integration of manned aviation with drones that are already using geometric altimetry in current operations, and also integration with HAOs (precision of barometric altimeters above Flight Level 800 is challenging). The research will need to consider aspects related to the transition from barometric to geometric altimetry (*R&I need: optimum green trajectories*).
- **Evolution of separation minima, including RVSM 2.** Building on the work of the SESAR 2020 ER project R-WAKE, the objective is to develop and validate a concept of operations to enable the reduction of vertical separation minima to 500 ft in a geometric altimetry environment, potentially in combination with a concept for new dynamic and/or geometry-dependent separation minima in the horizontal dimension. It is expected that the RVSM 2 concept will bring increased capacity (an estimated increase of 20 %) and reduced CO_2 emissions by making it possible for more aircraft to cruise at their preferred altitude. Safety benefits are also expected, because the concept also includes an increase in separation minima (e.g. vertical separation increases to 1 500 ft, or there is a requirement to add a small (e.g. 1 NM) horizontal separation to the 1 000-ft separation minimum for certain aircraft pairs when atmospheric conditions are known to be such that wake turbulence is especially persistent, thereby reducing the risk of wake encounters in the en-route phase of flight). The scope of the research includes investigating advanced modes of separation (e.g. dynamic separation) based on predictive modelling and ML techniques and enabled by further automation and improved connectivity. In addition, the dynamic calculation of the necessary separation parameters between aircraft (horizontal and vertical) to meet a minimum acceptable safety level (i.e. moving away from pre-determined separation standards) should be addressed. The separation minima to be developed include both minimum radar separation (MRS), which aims to keep the risk of collision sufficiently low to meet the target level of safety (TLS), and minimum wake separation (MWS), which aims to keep the risk of wake encounter sufficiently low to meet the TLS; the minima to be applied in operations will always be the maximum of the applicable MRS and TLS. Please note that it is expected that the RVSM 2 concept will not be possible with the precision that barometric altimetry can provide (it will require the increased precision provided by geometric altimetry, as described in the previous bullet point). The dynamic weather-

and geometry-dependent pairwise distance-/time-based separation minima for en-route airspace and the TMA will allow the separation minimum between two aircraft to be reduced under certain weather conditions (e.g. depending on the location of the tropopause, on wind); the separation to be applied will be the greatest of the MRS and the MWS. The operational improvement will also require combined separation minima and consideration of flight-specific data *(R&I need: optimum green trajectories)*.

- **Introduction of environmental considerations into the European route-charging scheme.** This element builds on the evolution of separation minima as described in the previous bullet point and covers research into the potential evolution of the route-charging scheme to incorporate environmental considerations, such as lower charges for flying at valley hours, lower charges for flying at suboptimal flight levels (or flying longer 2D routes) to reduce non-CO_2 impacts, lower charges for lighter flights accepting voluntary level-capping in order to make the best flight levels available to heavier aircraft and higher charges for aircraft with lower load factors or for business aircraft *(R&I need: accelerating decarbonisation through operational and business incentivisation)*.

2.1.4.2.8 Topic HORIZON-SESAR-2022-DES-ER1-WA2-8: ATM application-oriented research for AI for aviation

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Project results are expected to demonstrate the positive impact of AI-based solutions on operational mitigation of aviation's environmental impact.
- **Capacity.** Project results are expected to contribute to capacity by addressing AI-based human operator support tools to ensure the integration of new entrant aircraft types.
- **Operational efficiency.** Project results are expected to improve the operational efficiency by enabling better traffic predictions and forecasts, thus contributing to punctuality.
- **Safety.** Project results are expected to maintain at least the same level of safety as the current ATM system.
- **Security.** Project results are expected to maintain at least the same level of security as the current ATM system.

Scope

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the AI for aviation flagship.

- **Aviation/ATM AI infrastructure.** AI is largely dependent on data, which is required to develop AI algorithms and to validate them. Thus, the challenge is to develop an appropriate aviation/ATM AI infrastructure and/or exploit existing ones that can capture the current and future information required to support AI-enabled applications, with the required software development processes, using robust architectures for ATC systems to provide ATCOs and pilots with a good level of confidence in automated decision-aiding tools. This includes capability development, trustworthiness, safety and airworthiness. Furthermore, there is a need to foster access to and sharing of data while looking at aspects related to data quality, data integrity, data ownership, data security, the trust framework and data governance. This element also includes the creation of an exploitation plan detailing future steps after the end of the project *(R&I need: trustworthy AI powered ATM environment)*.

- **AI-powered human–machine interactions.** Moving beyond the state of the art, this element covers research on how human–machine interactions can be boosted to the highest level of automation, including through branches of AI such as reinforcement learning, explainable AI and natural language processing. The research results should demonstrate how the technology can support ATCOs in carrying out their tasks, not redefine the role of the human (e.g. demonstrate an increase in human capabilities during the execution of complex scenarios or a reduction in human workload in the execution of standard tasks *(R&I need: human–AI collaboration: digital assistants)*.
- **AI-powered co-piloting.** Similarly to the research described in the previous bullet point, this element aims to investigate how AI can support pilots and reduce their workload. Research should focus, for example, on how to exploit high levels of automation to perform non-critical tasks and how the HMI should work during such operations *(R&I need: human–AI collaboration: digital assistants)*.
- **AI for complex operations.** This research is about the development of AI-based human operator support tools to ensure the safe integration of new entrant aircraft types into an increasingly busy, heterogeneous and complex traffic mix (i.e. UAVs, supersonic aircraft, hybrid and fully electric aircraft) This should also cover the wider implications for other organisations and the impact on the network *(R&I need: human–AI collaboration: digital assistants)*.
- **Sustainable trajectory.** This element will involve developing AI-based solutions for operational mitigation of aviation’s environmental impact, such as near-real-time network optimisation (airspace/route availability) and use (on-the-fly flight planning), in conjunction with meteorological data now-casting, which could be made possible through AI *(R&I need: AI Improved datasets for better airborne operations)*.

2.1.4.3 *Work Area 3: Knowledge transfer network (coordination and support action)*

Specific conditions for WA3	
Expected EU contribution per project	The SESAR 3 JU estimates that an EU contribution of around EUR 3.75 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 3.75 million.
Type of actions	Coordination and support action (CSA)
Legal and financial set-up of the grant agreements	Beneficiaries may provide financial support to third parties. Such support can be provided only in the form of a grant. The maximum amount to be granted to each third party is EUR 60 000. Grants awarded under this topic will be linked to the following actions: HORIZON-SESAR-2022-DES-ER-01.

	A collaboration agreement is required.
Other requirements	The maximum project duration is 48 months.

2.1.4.3.1 Topic HORIZON-SESAR-2022-DES-ER1-WA3-1: Knowledge transfer network

Expected Outcomes

The support action is expected to result in:

- cross-fertilisation of knowledge from other disciplines that will encourage the exploration of innovative and unconventional ideas and research directions in ATM;
- the establishment and consolidation of a strong links between cutting-edge research, the operational challenges faced by industry and Europe's policy agenda on transport, digitalisation and sustainability;
- the identification of 'thematic challenges' pinpointed by the wider research community and supported by mechanisms such as dedicated workshops and 'catalyst funding'-focused projects, able to stimulate the movement of exploratory research results to higher levels of maturity and promoting cooperation between academia and the industry;
- the maintenance and continual updating of the knowledge hub (i.e. wiki) set up by the SESAR 2020 ER project Engage, representing a one-stop, go-to source for information and a single European point of entry for ATM knowledge;
- support for the execution of, and contributions to improving, the SESAR Digital Academy initiative, to increase professional/learning opportunities for up-and-coming researchers and the future aviation/ATM workforce, and to foster equal opportunities.

Scope

The knowledge transfer network will be responsible for at least the following activities.

- **ATM concepts roadmap.** The network will produce and maintain a long-term roadmap for innovative and interdisciplinary ATM concepts. This will entail monitoring, identifying and analysing new opportunities for innovative ATM research relevant to the evolution of the European ATM system.
- **Take-up.** The network will stimulate the transfer of exploratory research results to ATM applications-oriented research and onwards to industrial research.
- **Wiki.** Building on the one-stop knowledge hub (i.e. wiki) being developed by the current ER project Engage (with an estimated extended grant end date of 30 June 2022), the selected consortium will be in charge of maintaining and updating the wiki with at least the following content:
    - **a research repository** for all research conducted within the framework of the SESAR R&I programmes (SESAR 1, SESAR 2020, Digital European Sky), clustered by themes, strands of research, operational improvements, project names, keywords, etc.

  - **a mapping of European university programmes**, featuring details of undergraduate programmes related to air transport engineering and aviation management, and postgraduate programmes that perform ATM-related research (regardless of the main research field).

- **Catalyst funding.** The network will be responsible for launching calls for catalyst research projects, managing the call text, the selection process, funding and promotion, and coordinating the participation of the funded projects in key SESAR Digital Academy events.

- **SESAR Digital Academy initiative.** The network will support the European ATM education and training required to develop new talent with a deep knowledge of future ATM scientific research needs, sustain a supply of bright young research talent in the long term and stimulate the next generation of ATM operational and engineering staff. To achieve this, the selected consortium will carry out at least the following activities.

  - It will launch calls for PhD research projects, managing the call text, the selection process, funding and promotion, and coordinating the participation of the funded PhD students in key SESAR Digital Academy events. It will also be responsible for signposting other financial support opportunities for students pursuing PhDs and other postgraduate theses or dissertations on innovative research ideas.
  - It will facilitate placements and/or training opportunities, offering students a chance to develop new skills and gain valuable industry experience.
  - It will support the promotion of the SESAR Young Scientist Award campaigns, helping to ensure the visibility of the campaign and encouraging aviation students to submit applications.
  - It will support the SESAR 3 JU in the preparation and execution of webinars and other similar events (see also the following bullet point).

- **Events, publications and website.** The network will support the SESAR 3 JU in the preparation and execution of the SESAR Innovation Days, including calls for contributions, selecting papers and posters, promotion, defining the technical programme, chairing panels, identifying speakers including keynote speakers, etc. In addition, the network will organise workshops and symposiums, ATM research summer schools, and digital challenges / hackathons, and will produce newsletters and carry out other actions aimed at the dissemination and sharing of SESAR exploratory research and the network's results, potentially including the publication of a European ATM periodic academic journal and/or a series of special issues in existing journals. It will also provide support to the SESAR 3 JU in the management of the SESAR web pages (including the SESAR Digital Academy web page), updating them and integrating the latest content.

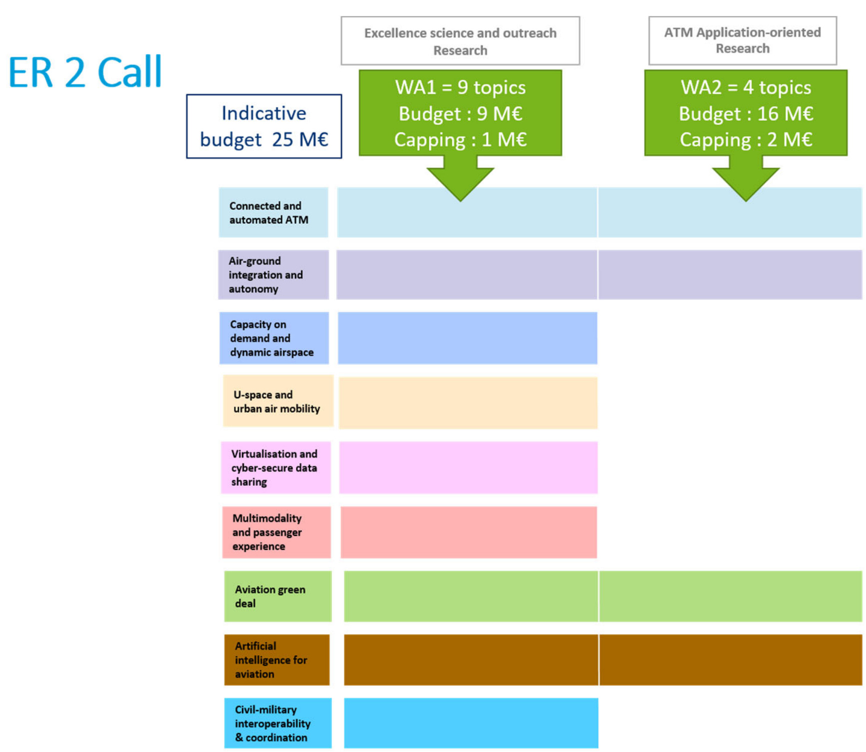
2.2 Call HORIZON-SESAR-2023-DES-ER-02

2.2.1 Scope of the call

The second SESAR 3 Exploratory Research call (HORIZON-SESAR-2023-DES-ER-02) fully funded under Horizon Europe, covers exploratory research activities that will drive the development and evaluation of innovative or unconventional ideas, concepts, methods and technologies that can define and deliver the performance required for the next generation of European ATM systems.

This call is composed of two work areas (WA):

- **WA1 (ATM excellent science and outreach)** comprises the exploratory research activities necessary to develop new concepts for ATM beyond those identified in the European ATM Master Plan, and will help to develop emerging technologies and methods to the level of maturity required to feed the applied research conducted by the SESAR 3 JU. WA1 covers innovative content at pre-TRL1 (TRL0) maturity level and the minimum target maturity level is to complete TRL1.
- **WA2 (ATM application-oriented research)** comprises the exploratory research activities aiming to bridge the results of ATM excellent science and outreach and the higher maturity ATM research performed with a wider research community, as part of SESAR 3 JU industrial research activities. It also aims at providing the necessary scientific support to ATM change. WA2 covers content that has already completed TRL1 in previous research activities and the objective is to complete TRL2.



The following principles shall be taken into consideration by any proposal addressing the topics under this call:

- Proposals can target higher maturity levels than those initially expected for WA1 on excellence science and outreach (TRL1) or WA2 on applications oriented research (TRL2). However, following the project handbook principles, the type of deliverables and content that are required as evidences for successfully achieving such maturity level need to be in line with those expected for Industrial Research activities.
- The proposal shall identify the impacted stakeholders by the research element(s) under scope e.g., airspace users, ANSPs, NM, etc.
- The call proposes for each topic a number of non-prescriptive innovative research elements that could be used to achieve the expected outcomes. Proposals are not requested to address all the research elements under a topic. Proposals can address additional research elements (not listed in the call): in this case, the proposal must provide adequate background and justification to ensure clear traceability of the new research element(s) with the R&I needs set out in the SRIA for each R&I flagship.
- Proposals are not requested to address all expected outcomes under each topic. Each proposal shall justify with solid arguments (ideally quantitatively, if not at least qualitatively) how the proposed research will contribute to the expected outcomes.
- DES ER-01 projects are already in execution: proposals shall take care of avoiding duplication in terms of scope with research elements under DES ER-01, or justify the complementarity if this happens.
- Proposals shall demonstrate a sound knowledge of the state-of-the-art on current operations and relevant previous R&I work (both in and outside of SESAR) and demonstrate their innovation potential i.e. how their proposed work will allow progressing beyond the state of the art. Proposals shall avoid any duplication with past R&I activities (e.g. SESAR 2020 programme ER projects).
- **For the WA1 only**, considering that the budget is shared amongst the 9 covered topics, and in order to foster innovative ideas, proposals applying to one topic **can incorporate research elements from other topics within WA1**, as required to complete the scope of the proposal.

2.2.2 General conditions for the call

Unless otherwise stated, the call follows the general conditions laid down in the General Annexes to the Horizon Europe Work Programme for 2023–2024, adopted by the European Commission ([33]).

Topic	**Type of actions**	Budget (million EUR) for 2022	**Maximum expected EU contribution per project (million EUR)** ([34])

([33]) European Commission Decision C(2022)7550 of 6 December 2022.
([34]) Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.

Opening: 29 June 2023 Deadline (35): 15 November 2023			
HORIZON-SESAR-2023-DES-ER2-WA1-1	Research and innovation action (RIA)	9.00	1.00
HORIZON-SESAR-2023-DES-ER2-WA1-2			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-3			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-4			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-5			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-6			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-7			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-8			1.00
HORIZON-SESAR-2023-DES-ER2-WA1-9			1.00
HORIZON-SESAR-2023-DES-ER2-WA2-1	Research and Innovation Action (RIA)	16.00	2.00
HORIZON-SESAR-2023-DES-ER2-WA2-2			2.00
HORIZON-SESAR-2023-DES-ER2-WA2-3			2.00
HORIZON-SESAR-2023-DES-ER2-WA2-4			2.00
Overall indicative budget	25.00[36]		

Table 53: Budget allocation and maximum expected EU contribution per project per work area under the HORIZON-SESAR-2023-DES-ER-02 call for proposals

Type of conditions	Information on the conditions
Admissibility conditions	The conditions are described in General Annex A to the Horizon Europe work programme for 2023–2024.
Eligibility conditions	The conditions are described in General Annex B to the Horizon Europe work programme for 2023–2024.
Financial and operational capacity and exclusion	The criteria are described in General Annex C to the Horizon Europe work programme for 2023–2024.
Award criteria	The criteria are described in subsection 2.1.3 below.
Documents	The documents are described in General Annex E to the Horizon Europe work programme for 2023–2024.

(35) The Executive Director responsible may delay the deadline(s) by up to 2 months. All deadlines are at 17.00.00 Brussels local time.

(36) The budget for the HORIZON-SESAR-2023-DES-ER-02 call for proposals was foreseen at million EUR 23.75 in the MAWP can be increased to million EUR 25.00 by using appropriation left over on the ER1 call for proposals.

Legal and financial set-up of the grant agreements	The rules are described in General Annex G to the Horizon Europe work programme for 2023–2024. The following exceptions apply. 3) Beneficiaries will be subject to the following additional dissemination obligations: ○ beneficiaries must make proactive efforts to share, on a royalty-free basis, in a timely manner and as appropriate, all relevant results with the other grants awarded under the same call; ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement. 4) Beneficiaries will be subject to the following additional exploitation obligations: For the purpose of complying with the objectives set in Council Regulation (EU) 2021/2085, the SRIA and the European ATM Master Plan; ○ beneficiaries must make available for reuse under fair, reasonable and non-discriminatory conditions all relevant results generated, through a well-defined mechanism using a trusted repository; ○ if the purpose of the specific identified measures to exploit the results of the action is related to standardisation, beneficiaries must grant a non-exclusive licence to the results royalty-free; ○ if working on linked actions, beneficiaries must ensure mutual access to the background to and to the results of ongoing and closed linked actions, should this be necessary to implement tasks under the linked actions or to exploit results generated by the linked actions as defined in the conditions laid down in this biannual work programme and in the call for proposals; ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement.
Other conditions	The maximum project duration is 30 months, including a 6-month period at the end of the project life cycle to undertake communications, dissemination and exploitation activities in relation to the research results.

Table 54: General conditions for the HORIZON-SESAR-2023-DES-ER-02 call for proposals

2.2.3 Award criteria

Type of actions	Excellence *(The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)*	Impact	Implementation

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Research and innovation actions (RIA)	1. Clarity and pertinence of the proposal: degree to which the objectives, scope and requirements set out in the call material are well understood and fully addressed. 2. Soundness of the proposed methodology for developing the SESAR solutions, including the underlying concepts, models, assumptions and interdisciplinary approaches. This criterion also includes appropriate consideration of the integration of a gender dimension into R&I content and the quality of open science practices ([37]), including sharing and management of research outputs and engagement of citizens, civil society and end users, where appropriate. 3. Level of awareness of the state of the art: degree to which the proposal demonstrates knowledge of current operations and relevant previous R&D work (both within and outside SESAR), explains how the proposed work will go beyond the state of the art and demonstrates innovation potential.	1. Credibility of the pathways to achieve the expected outcomes and impacts specified in the call material. 2. Suitability and quality of the measures in terms of maximising expected outcomes and impacts, as set out in the dissemination and exploitation (D&E) plan, including communication activities.	1. Quality and effectiveness of the work plan and assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. 2. Capacity and role of each participant and the extent to which the consortium as a whole brings together the necessary expertise.

2.2.4 Specific conditions and description of topics for each work area

2.2.4.1 *Work Area 1: ATM Excellent science and outreach*

ATM excellent science and outreach exploratory research activities aim at developing innovative or unconventional ideas, concepts, methods and technologies for ATM beyond those identified in the European ATM Master Plan that have not yet achieved TRL1. The proposed potential solutions will

([37]) See EU's open science policy (https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en).

help developing emerging technologies and methods, at least, to the level of maturity required to feed the next step in the R&I pipeline i.e. future applied research activities.

Specific conditions for WA1	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 1.00 million would allow the outcomes to be addressed appropriately. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 9.00 million.
Type of actions	Research and innovation action (RIA)
Procedure	The procedure is described in General Annex F to the Horizon Europe work programme for 2023–2024.
Legal and financial set-up of the grant agreement	Grants awarded under this work area will have to submit the following deliverables: • Concept outline • Exploratory research plan (ERP) • Exploratory research report (ERR) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 3 months after signature date and periodically updated)

2.2.4.1.1 *Topic HORIZON-SESAR-2023-DES-ER2-WA1-1: ATM Excellent science and outreach for connected and automated ATM*

Expected outcomes

Project results are expected to contribute to the following expected outcomes:

- **Environment:** the proposed solutions should have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint;
- **Capacity:** the proposed solutions are expected to contribute to capacity by improving runway throughput and ground operations, as well as the use of medium/high/very high density en-route/TMA airspace;
- **Cost-efficiency:** the proposed solutions are expected to justify the investment costs related to the adoption of automated technologies and tools;
- **Safety:** the proposed solutions are expected to maintain at least the same level of safety as the current ATM system, in a more connected and automated environment;

- **Security:** The proposed solutions are expected to identify and mitigate the potential security risks deriving from having a more interconnected and automated ATM system.

Scope

The future ATM environment foreseen by the Digital European Sky vision will be increasingly complex, integrating new airspace users' needs, new airspace vehicles with different performances than conventional aircraft e.g., different speeds and altitudes, etc. The challenge is to propose and develop innovative or unconventional ideas to increase the level of automation (i.e., level 4 (high automation) and level 5 (full automation)) and digitalization in Europe's ATM and design a future ATM infrastructure that would help reducing rigidities in the ATM system and making it even safer than today's while improving its scalability and resilience. Secure data sharing between all the components of the ATM infrastructure and the relevant non-ATM stakeholders is another cornerstone of this vision. Research proposals shall aim at leveraging and exploiting emerging digital technologies that could help transforming the sector, in support of new airspace users and design a future ATM infrastructure commensurate with the performance required by each airspace user type and environment. This includes those environments in the transition areas between Europe and neighbouring ICAO regions, which may have specific regulations and challenges.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on research elements other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the connected and automated ATM R&I flagship:

- **Moving from magnetic to geographical bearings.** This research element aims at moving from magnetic to geographical bearings. The objective is to investigate the operational aspects and potential impact on different actors e.g., airspace users, pilots, ATCOs, procedure design, aerodrome operator, etc. An estimation of the potential benefits would also be required, as well as the definition of standardization needs. Research aims also at studying what would be needed from a CNS and avionics perspective (including changes on, for example, flight management system (FMS), surveillance infrastructure, etc.) for this evolution (*R&I need: enabling the deployment of a performance-based CNS service offer*).
- **Autonomous runway inspections and surveys.** Research aims at addressing technical and operational aspects related to autonomous runway inspections and surveys (e.g., laser scans, cameras, drones, etc.) for assessing runway conditions under the EU Global Reporting Format. Research shall be complementary to and avoid duplication with on-going activities under EASA (e.g., project "Runway Micro Texture" that involves laser scans). The scope covers foreign object or debris (FOD) detection, inspection of runway (RWY) aids, etc. Research shall address the impact on the aerodrome operations e.g., performance aspects *(R&I need: runway use optimisation through integrated use of arrival and departure TBS tools)*.
- **Review separation principles at and around airports (risks analysis vs. separation standards).** Research aims at reviewing the principles of minimal runway separation for both independent and dependent operations and developing potential solutions to minimise separation through automation. The research element aims at building a minimum acceptable safety model based on the probability of collision and taking account of geometry, relative speed, ground and airborne systems capabilities, adherence to a planned trajectory, etc. Research shall build on time-based separation

and PBN research taking advantage of airborne navigation capabilities, surveillance capabilities, etc. and may require advanced tools based on trajectory prediction and conflict detection / conflict monitoring. The objective is to increase capacity by safely placing aircraft closer together and to make a better use of available infrastructure. Results of this research aim at moving away from pre-determined separation standards (*R&I need: runway use optimisation through integrated use of arrival and departure TBS tools*).

- **Automated ATC in airports operations.** Research aims at developing and validating operational concepts for higher levels of automation in airport operations (levels 4 and 5 as per the ATM Master Plan). The proposed solutions shall be fully consistent with human capabilities. The potential use cases include e.g., automated guidance system for ground movements, automatic ground conflict resolution, enhanced functionalities for digital towers, the application of ML techniques to help in decision making building on similar situations that happened in the past, etc. Research shall address the specific challenges that hinder the application of machine learning (ML) and artificial intelligence (AI) methods to increase the level of automation in airport operations (e.g., transparency, generalisation, etc.). Research shall take into account the recommendations provided by the “expert group on the human dimension of the Single European Sky” in relation to evolving roles in environments with high levels of automation. Research aims at reviewing all the roles, responsibilities and tasks of the different actors (airborne and ground, ATM and U-space, operational and technical), as well as training needs and change management. Research shall plan a close coordination with EASA to ensure complementarity and consistency with EASA activities (e.g., on AI). Research shall take into account the output of previous exploratory research projects in this area e.g., AEON, TACO *(R&I: airport automation including runway and surface movement assistance for more predictable ground operations)*.
- **Safety, ethical and liability challenges of increased automation.** Research aims at investigating the safety, ethical and liability challenges associated with increased autonomy and automation level in air traffic management (ATM). Research may address the challenges imposed by artificial intelligence (AI), AI training data and AI-human partnerships, distributed systems-of-systems and decision-making, the human-machine interface and the changing role of the human – pilots and air traffic controllers – in the system, etc. Research may investigate the concept of trusted autonomy (TA), which refers to two or more interacting and self-governed autonomous intelligent systems (including humans) where one side of the interaction is willing to delegate a task that will make it vulnerable to other parties in the interaction who are willing to accept and can autonomously perform the task. This includes the study of how the interface between these systems and their end users should be designed. The integration of distributed cryptographic systems (e.g. blockchain, ZkP, smart contracts, etc.) with autonomous systems and how they could support in decision making is also under scope (*R&I need: role of the human*).
- **Models and theories of behaviour change.** An active role for the human factor in system design will be vital to support the transition from the tactical involvement of controllers to management of traffic “by exception”. Research is needed to understand and manage the impact of system changes on human performance and workload in the long term. Readiness to change, barriers to change and likelihood of relapse should be addressed in system design, monitoring and improvement over the long term. Both models of behaviours and behavioural change theories should be investigated as diagnostic tools

to explain and predict specific behaviours. Furthermore, resilience in handling abnormal situations should be addressed, in order to understand how this resilience can be maintained with reduced human involvement *(R&I need: role of the human).*

- **ATCOs up-skilling, reskilling and de-skilling in the face of new technologies**. The introduction of future new technologies and higher levels of automation may increase the space for potential and new type of errors that cannot be easily foreseen. Research aims at analysing the potential of these new technologies to disrupt established patterns in coordinated activity between ATCOs' and between ATCOs' and flight crews. In particular, research covers the needs for up-skilling, reskilling and/or de-skilling ATCOs in the future environment. This may imply the need of developing new mental models, how the AI system works, how it fails, why it fails, and how to adapt (*R&I need: role of the human*).
- **Innovative ways to present traffic to ATCOs.** The delivery of ATM services irrespective of physical infrastructure or geographical location implies that local operational and geographical information of a sector might not be known in advanced. Research aims at exploring innovative ways to present the traffic to the ATCOs, so that the flight representation on the screen does not necessarily imply their visualisation on the zenital view of a sector. Research may develop means to help future ATCOs bridging their lack of local knowledge and reducing training time. Technologies based on extended reality (XR) may be used in the proposed research (*R&I need: role of the human*).

2.2.4.1.2 Topic HORIZON-SESAR-2023-DES-ER2-WA1-2: ATM Excellent science and outreach for air–ground integration and autonomy

Expected outcomes

Project results are expected to contribute to the following expected outcomes:

- **Operational efficiency**: the proposed solutions shall improve operational efficiency thanks to advanced communication means and increased automation. In particular, further improvements on vertical flight efficiency and cruising/taxiing fuel consumption are expected;
- **Environment:** the proposed solutions shall aim at optimising fuel-burn and the CO_2 emissions per flight;
- **Capacity:** the integration of new airspace users and air vehicles (unmanned aircraft, HLO operations, etc.) shall not negatively impact capacity;
- **Cost-efficiency:** is expected to be improved thanks to the new services supported by air-ground connectivity;
- **Safety:** increased air-ground autonomy will enable the human actors to be discharged from routine tasks and to focus on strategic tasks, including safety oversight of the operations;
- **Security:** The proposed solutions are expected to identify and mitigate the potential security risks deriving from the increased connectivity between stakeholders.

Scope

The Digital European Sky vision foresees the progressive evolution towards autonomous flying, increasing the global ATM performance in terms of capacity, operational efficiency and accommodation of new and/or more autonomous forms of mobility and air vehicles, i.e. supporting the evolving demand in terms of diversity, complexity from very low-level airspace to high level operations. The challenge is to propose and develop potential innovative or breakthrough solutions to allow the accommodation or full integration of these air vehicles, which will have a high degree of autonomy and will use digital means of communication and navigation. This requires closer integration and advanced means of communication between vehicle and infrastructure capabilities so that the infrastructure can act as a digital twin[38] of the aircraft. Future operations should therefore rely on direct interactions between air and ground automation, with the human role focused on strategic decision-making while monitoring automation. The objective is to ensure that both manned and unmanned aerial vehicles operate in a seamless and safe environment using common infrastructure and services supporting a common concept of trajectory-based operations.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the air-ground automation and autonomy R & I flagship:

- **New advanced means of communication between vehicle and ground infrastructure capabilities**. In the future, the aim is to enable a much richer integration of ground infrastructure and air vehicles, so that ground information of vehicles, operations, etc. becomes similar to a digital twin of the traffic and vehicles situation. Future operations rely on direct interactions between air and ground automation, with the human role focused on strategic decision-making while monitoring automation support. Research shall address innovative and automated means of air ground communication. Research may address different operating environments e.g., airport, en-route, TMA. In the airport environment, research shall take into consideration EASA Triple 1 research (*R&I need: Enabling greater ground and airborne integration and wider performance*).
- **Air-to-air (A/A) communication.** The objective of this research element is to address A/A communication to enable new operations and to support advanced separation management and safety nets in the context of the safe cohabitation of different types of air vehicles (e.g., high altitude, drones, business aviation, scheduled aircraft, rotorcraft, etc.). This includes the definition of potential use cases describing the application of A/A communication, potential technical solutions, spectrum needs, risk assessment of loss of A/A communications, etc. A/A communication in the context of ATM/U-space, in particular for the safe co-habitation of these diverse aerial vehicles, is also in scope (*R&I need: enabling greater ground and airborne integration and wider performance*).
- **Air-to-air (A/A) exchange services.** Research addresses the definition of air-to-air services for the dissemination and exchange of relevant information (e.g., meteorological weather hazards, wake vortices, trajectory information between aircraft for operational purposes, etc.). Significant weather events, such as wake turbulence,

[38] A digital twin is a digital representation of an intended or actual real-world physical product, system, or process (a physical twin) that serves as the effectively indistinguishable digital counterpart of it for practical purposes, such as simulation, integration, testing, monitoring, and maintenance.

icing, etc., captured by on-board system, which may be of safety concern to individual or multiple aircraft, could be broadcast to other airspace users. The objective is to increase safety and operational efficiency (*R&I need: enabling greater ground and airborne integration and wider performance*).

- **Improved air safety using on-board / ground wake turbulence detection and prediction.** Research focuses on how safety could be improved thanks to the use of wake turbulence detection information, which could be provided via different means (either air or ground based). This information could improve the pilot situational awareness regarding the surrounding wake turbulence events, since he/she will have access to this wake turbulence information through on-board sensors. Regarding the on-board detection, the aim is to ensure tactical measurement of wake turbulence activation of flight control response countering wake turbulence impact in order to increase the stability of the aircraft, thereby improving safety and capacity. Research may also address ground-based en-route ATC wake turbulence alerting: the ground-based prediction would rely on aircraft trajectory prediction, accurate higher altitude wind information (using downlink / Mode-S) and wake turbulence encounter risk model. The technical ground-based en-route wake turbulence encounter risk prediction capabilities need to be assessed from a feasibility and performance perspective. Research aims at confirming the technical capability to predict the risk with sufficient accuracy while limiting the risk of false alarm to an acceptable level, thus delivering the expected safety benefits. The on-board based detection has been addressed to some extent in SESAR (PJ.06.08.01/PJ.12.02.02 and PJ.02 in Wave 1) but the concept presented some technical challenges, which should be addressed. For the ground-based part, work performed in the non-SESAR project SAFEMODE shall be considered (R&I need: enabling greater ground and airborne integration and wider performance).

2.2.4.1.3 Topic HORIZON-SESAR-2023-DES-ER2-WA1-3: ATM Excellent science and outreach for capacity on demand and dynamic airspace

Expected outcomes

Project results are expected to contribute to the following expected outcomes:

- **Capacity:** the proposed solutions are expected to provide a more stable and predictable level of capacity in all-weather operations. In addition, by providing capacity dynamically where and when it is needed and re-configuring the airspace to match the traffic flows, overall system resilience will be significantly increased;
- **Operational efficiency:** the proposed solutions are expected to improve operational efficiency in terms of human performance and the resilience of the staff involved (e.g., ATCOs) to new working methods generated because of new/different task allocation strategies. Trajectory management and dynamic airspace configurations will provide further improvements in vertical flight efficiency;
- **Cost-efficiency**: dynamic airspace configurations, capacity-on-demand, ATCO training programmes will provide scalability. ATCO productivity is expected to increase significantly;
- **Safety:** the proposed solutions are expected to maintain at least the same level of safety as the current ATM system.

Scope

The future ATM system will require increased agility and flexibility in providing capacity where and when it will be needed across the network, particularly for maximising the use and performance of limited resources, i.e. airspace and ATCOs. The challenge is to propose innovative potential solutions that will supply the required capacity on demand in a dynamic, agile and resilient manner, improving cost and flight efficiency while maintaining (or improving) safety. These solutions shall enable the dynamic reconfiguration of resources and the provision of new capacity-on-demand services to maintain safe, resilient, smooth and efficient air transport operations while allowing for the optimisation of trajectories even at busy periods. The proposed innovative solutions shall aim at responding to emerging business needs that can only be addressed through standardised data sharing between air traffic service providers using a highly interconnected, digital and resilient network.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the capacity on demand and dynamic airspace flagship:

- **Increasing the use of middle airspace.** This element addresses the potential business case for increasing the use of middle airspace (approximately between 15 000 ft. and 25 000 ft.) by different type of aircraft (jet engine aircraft, aircraft with new propulsion systems, etc.). Research shall address the environmental impact of providing ATFM slots for flights in middle airspace e.g., fuel consumption, emissions, etc. and the trade-offs with other KPAs such as increased capacity (and reduced delays) *(R&I need: on-demand ATSs)*.
- **Network performance cockpit for "network minded" decision making.** This research element aims at establishing a network performance cockpit for "network minded" decision making including support to enhanced connectivity both for identifying unattended business opportunities and for managing disruptive crises. How to optimize the current computer assisted slot allocation (CASA) algorithm to consider flow interactions and to implement regulations based on traffic flows with the consequent reduction of delay, and therefore, overall network performance improvement is under scope. In addition, these evolutions may include the consideration of actual aircraft performance, flight profile preferences by airlines and direct routings given by controllers in the en-route phase of flight. This new approach to set ATFCM regulations will improve the ATFCM network decision-making and will avoid unnecessary and ineffective regulations by considering optimal solutions at regional level. In support of the network performance management, research shall propose flow-monitoring dashboards (*R&I need: on-demand ATS*).
- **Global weather and environment monitoring ATM network.** The key objective is to design and start developing a single monitoring and reporting system for a green ATM, covering all aviation impacts: greenhouse emissions, noise and air pollutants and relevant safety and security threats. This research element addresses the secure integration of multiple data to monitor, collect, integrate and present weather and environment information to the different stakeholders on the ATM system including: pollution, contrails, noise, weather, vehicle status, congestion and other safety and security threats, such as volcanic eruptions, earthquakes, tsunamis, extreme weather events, conflicts, etc. The primary source of the data may include a variety of sensors: ground, air, stratosphere, space-based, etc.: research covers the challenge to integrate / fuse all this information that may have different granularity, rate, characteristics, etc.

Research includes the definition of potential solutions to predict safety and security threats in negatively affecting ATM safety, manage risks as they emerge and recover from disruption caused by, for example, factors such as disease, climate change, volcanic eruptions and solar storms that affect electronic equipment. While focused on the ATM dimension, proposals shall consider potential constraints imposed by other domains as well as collateral impacts of ATM research on other domains (*R&I: ATM continuity of service despite disruption*).

2.2.4.1.4 Topic HORIZON-SESAR-2023-DES-ER2-WA1-4: ATM Excellent science and outreach for for U-space and urban air mobility

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions should have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint;
- **Capacity**: U-space shall not negatively affect the capacity of the ATM system and will enable additional system capacity by enabling large volumes of unmanned aircraft to access the airspace;
- **Passenger experience:** U-space will open the way to new services (delivery, inspection, security, etc.) that will increase the wellbeing of European citizens. Particular attention must, however, be paid to safeguarding privacy and ensuring social acceptance;
- **Safety:** the proposed solutions are expected to maintain at least the same level of safety as the current ATM system;
- **Security:** the proposed solutions are expected to maintain at least the same level of security as the current ATM system;
- **Cost-efficiency**: the proposed solutions are expected to reduce the operation costs of unmanned aircraft.

Scope

The Digital European Sky vision includes the seamless integration of U-space with the ATM system to ensure safe and fair access to airspace for all airspace users, including innovative air mobility (IAM[39]) flights departing from airports. The challenge is to define and develop breakthrough solutions that will enable U-space to provide the means to manage safely and efficiently high-density traffic at low altitudes involving heterogeneous vehicles (small unmanned aerial vehicles, electric vertical take-off and landing – eVTOLs - and conventional manned aircraft), including operations over populated areas and within controlled airspace. Research aims at developing solutions that will support the seamless integration of U-space with the ATM system to ensure safe and fair access to airspace for all airspace users, including UAM flights departing from airports.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they

[39] As per the EU Drone Strategy 2.0, IAM includes UAM, Regional Air Mobility and International Air Mobility.

include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the U-space and UAM flagship:

- **U-Space as accelerator of evolution of ATM.** This element explores whether U-space can be an accelerator of the ATM innovation life cycle, facilitating faster, lower-risk adoption of new technologies or approaches (automation, artificial intelligence (AI), internet of things (IoT), cloud, ML Ops, etc.). This could include, for example, the use of U-space communication solutions for air–ground communications on the airport surface (to free up the very high frequency (VHF) spectrum for use in the air), adaptation of U-space automation concepts to manned aviation (e.g., advanced automation). In terms of the evolution of ATM, the aim will be to exploit the potential use of U-space technologies and concepts for manned aviation, with a focus on exploring the potential applicability of advanced U-space services to uncontrolled airspace, in particular Class G airspace. Applications to higher airspace operations (HAOs) are also within the scope of this element (*R&I need: transfer of U-space automation technology to ATM)*.
- **Integrated CONOPS U-space / ATM** (*R&I need: enable UAM*). The research shall focus on:
  - The development of an integrated U-space / ATM CONOPS;
  - The evolution of CORUS CONOPS on U-space towards version 5.0 (research shall take into consideration the output of project CORUS-XUAM);
  - Provide a full U-space / IAM[1] roadmap from ER to deployment and elaboration of key pending R&D needs to be addressed in the different pillars of the R&I pipeline.
- **Urban airspace evolution.** The largest concentration of drones is expected over populated areas, but these will not be drone-only areas: manned flights will still need to operate like they do today (e.g., security forces, emergency services, etc.); many of the manned missions over urban areas require flexibility, loitering, etc. and are often of high priority. The future scenarios will combine manned aircraft and small drones in the same mission (e.g., events, emergency management, etc.). In addition, people-carrying eVTOLs, initially with an on-board or remote pilot and in the future autonomous, will also be introduced in the urban airspace. In the current environment, manned flights over urban areas are typically operated under VFR or special VFR rules; this set-up provides the flexibility required by their typical mission profiles, but if unchanged would be very limiting towards drone-manned aviation airspace sharing. The objective of the research is to investigate potential solutions to introduce drones in the urban environment while still allowing flexibility for manned aircraft and drones as required by the typical urban mission profiles. Solutions may include digital flight rules (to be developed) and/or the dynamic creation of corridors/reserved areas when required by the mission, with the definition of containment requirements. It is expected the research to address in particular the concept of 2D containment for VFR aircraft, considering the applicability of RNP-like navigation specifications for VFR aircraft or the development of specific navigation requirements for VFR aircraft, that potentially combine visual references with on-board instrument support. The research should aim at developing a scalable concept and deepen into its applicability at a small scale (a few drones and manned aircraft flying typical missions in the same area, representative of

[1] As per the EU Drone Strategy 2.0, IAM includes UAM, Regional Air Mobility and International Air Mobility.

the initial demand). The research may cover related urban-specific technical issues such as, *inter-alia*, C2 performance, GNSS performance and the potential areas with a microclimate that are often found in heavily built-up areas. Proposals should provide evidence that the applicants are familiar with the existing literature (e.g., previous SESAR research in this area, in particular PJ.34 project AURA research on ATM/U-space integration, previous SESAR U-space demonstrations, etc.) and existing standards (e.g., PBN/RNP) and describe how their proposed work would address the outstanding research challenges (*R&I need: enable UAM*).

- **Cooperative operations between drones.** This research element explores operations where several drones need to operate cooperatively, such as drone swarming, formation flying, etc. that could involve the coordination of several flight plans as well as their dynamic evolution. One example is the in-flight battery replacement (including fast charging) for electrical drones. Electrical aircraft may be the alternative for the aviation in a future where a key objective is to reduce emissions and noise. Batteries for aeronautical propulsion must evolve to accomplish with low weight, spatial restrictions, safety, reliability and environmental protection requirements. However, the low specific energy of batteries compared to the energy density of kerosene means reduced time and distance flown before the electric batteries run out and need to be replaced. In-flight battery replacement has been proposed as a way to address this limitation. Research can model the flight missions with in-flight battery replacement and investigate the U-space concepts that might be needed to support these operations. The research covers the integration of these missions in the U-space ecosystem. Drone design and battery design are outside of scope; projects shall use drones/drone models developed prior to the start of the project; however, the development of U-space systems and the integration of new drone models/drone mission models into the U-space systems or simulators are in scope (*R&I need: develop advanced U-space services*).
- **Improving risk modelling in U-space**. Research activities shall develop more accurate air-risk and ground-risk models (e.g., more accurate estimation of the severity of an aircraft crashing on the ground due either to a direct impact or to a mid-air collision) to better understand the link between the TLS and the subsequent impact e.g., frequency of fatalities, economic impact, reputational impact, etc. The scope may include the link to potential models for insurance policies. Research should consider different scenarios and variables (e.g., variable demand, etc.) and take into account also vertiports and, particularly, vertiports with more than one FATO and frequent operations. Research shall apply SORA methodology (*R&I need: U-space safety assurance*).
- **Integration of air vehicles and personal air vehicles.** In the future, new unmanned aircraft systems and personal air vehicles will fly long range and at higher altitudes to feed airports. This research will investigate the necessary seamless integration of those personal air vehicles into a more automated ATM *(R&I need: ATM/U-space integration)*.
- **ATM/U-Space/UAM performance interdependency and trade-offs.** U-Space services may have an impact in ATM performance results, presenting the need to explore potential trade-offs between different key performance areas / indicators. Research shall explore the interdependencies between the ATM and U-space/UAM performance framework, analyse interdependencies between these environments and potential trade-offs to facilitate the deployment of U-space/UAM new services (*R&I need: ATM/U-space integration*).

- **Multi-domain scenario generation service for U-space.** Research aims at developing a multi-domain what-if scenario generation service (air, land, surface, cybersecurity) capable of consuming and testing the services exposed from the flight plan management and drone fleet control platforms and being able to generate different load situations, emergencies or simulation of different scenarios in real time, such as:
  - The registration of fleets, drones, users and consumption of all services enabled for this purpose;
  - The whole process of requesting flight plans with different cases in order to validate the platform in all the allowed use cases;
  - Simulation and generation of different scenarios of thousands of drones in operation that consume in real time the position and the intersection services between drones and geofences for the drones control platform;
  - Generation of what-if scenarios where drones perform anomalous behaviours e.g. navigate outside the authorized corridor in the flight plan, enter in forbidden geofence, generate UAS with risk of collision with other drones etc.;
  - Creation of different emergency situations affecting drones with authorized flight plans, both before starting the flight and during the flight, so that the systems and communication services, and the warning and flight plans modification services are exposed to stress tests for the involved flees and scenarios, in order to stress the control systems and services in real time.

(R&I need: Support the development of the U-space regulatory framework and required standards).

2.2.4.1.5 Topic HORIZON-SESAR-2023-DES-ER2-WA1-5: ATM Excellent science and outreach for virtualisation and cybersecure data-sharing

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- Cost-efficiency: the proposed solutions are expected to report on the potential reduction in infrastructure costs. There are potential advantages deriving from the sharing of space-based services for aviation applications. Potential reduction in infrastructure and the possible creation of competition between future data suppliers will reduce costs;
- Capacity: the proposed solutions shall aim at improving capacity and resilience thanks to an increased flexibility of ATS provision to better adapt to traffic demand and make best use of capacity at network level;
- Safety: the proposed solutions are expected to maintain at least the same level of safety as the current ATM system;
- Security: The proposed solutions are expected to identify and mitigate the potential security risks deriving from the future data sharing service delivery model.

Scope

The Digital European Sky vision aims at removing the close coupling of ATM service provision to the ATS systems and operational procedures. The challenge is to propose innovative (or unconventional) ideas that will enable data-sharing, foster a more dynamic and resilient airspace management and ATM service provision, allowing air traffic service units (ATSU) to improve capacity in portions of airspace where traffic demand exceeds the available capacity. A more flexible use of external data services, considering data properties and access rights, would allow the infrastructure to be rationalised, reducing the related costs. The proposed solutions shall aim at rationalising and harmonising the ATM infrastructure while reducing the defragmentation. Virtualization solutions shall aim at completely decoupling ATM service provision from the physical location of the personnel and equipment, while scaling up and down of system performance in quasi-real time, as and when required.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the virtualisation and cyber secure data-sharing flagship:

- **Quantum computing in ATM.** Research aims at exploring how quantum computing could be applied in ATM and how it could impact ATM. The definition of potential measures to mitigate such impact (e.g., the impact of quantum computing on future security needs in ATM, etc.) is also under scope. Research may address other areas of interest such as NP-Hard problems coming from ATM (large-scale trajectory planning, airspace configuration optimization, etc.) *(R&I need: future data-sharing service delivery model)*.

- **Distributed/federated simulation in ATM.** This research element focuses on the use of distributed/federated simulations in ATM as a means of boosting participant numbers by being location and time-zone independent and allowing for a more flexible and iterative design process, especially for design evaluation in the lower maturity phases of system development. The concept of simulation as a service (SaaS) as a method to deploy simulation resources (e.g., simulators, models, input data) in the cloud using web services (WSs) for users to access these resources is also under scope. As this area is in the very early stages of development, research should determine how its potential could be explored, so that, for example, the problem of a shortage of participants can be circumvented, while contributing to the availability of a wider range of experts globally. With possible reductions in demand for mobility and in flexibility in both time and space due to post-pandemic effects, this solution could provide both methodological and organisational benefits to the ATM and research communities. Research may take into consideration the experience on the use of this type of simulation in the defence domain. Aspects such as cultural/local ATM operational differences should also be studied, and more complex network effects analysed by enabling cloud-based remote human-in-the-loop multisite simulations, in a direction which may have additional synergies with that of ATM virtualisation. Technical and operational challenges related to cloud-based distributed simulations, especially in the case of human-in-the-loop experimentation, should be addressed in relation to the need to temporally synchronise the entire experiment and associated events and interventions, align all actors' views, etc. Research may address different architectures e.g., distributed interactive simulation (DIS), high-level architecture simulation (HLA), etc. This challenge becomes even more difficult when trying to integrate legacy systems, which is another aspect that the research is expected to investigate from operational and technical points of view *(R&I need: scalability and resilience)*.

- **ATM data management.** The decentralization of the ATM system will bring with it the distribution of data management responsibilities among multiple actors. There is a need to establish requirements that ensure that data are correctly stored and that the transmission of data is carried out in a secure and traceable way, also protecting privacy requirements. Proposals should describe a specific ATM data management challenge, selecting one or more ways to store (e.g., data spaces), buy (e.g., data markets) and transmit ATM data so that the security and traceability is improved and propose a plan to validate the relevant hypothesis. Research may consider generic data encryption solutions that are in use in other industries that may be useful for ATM *(R&I need: cyber-resilience)*.

- **Cyber threat intelligence services in aviation.** The use of techniques based on machine learning (ML) to support cyber threat detection and mitigation is quite widespread in the state of the art of various industries (e.g., internet services, e-commerce, content delivery networks, etc.). The observation of anomalous traffic patterns or transactions enables the detection of cyberattacks. The transfer of these methods to aviation domain is not straightforward and, given the current tendency in aviation to enhance information-sharing to implement machine-to-machine automated functions (e.g., through SWIM implementation, increased bandwidth air–ground communications, etc.) while maintaining legacy systems built without any proper security policy, research in this area is needed. Research may address dynamic risk assessment (DRA) and business impact assessment (BIA) techniques and improve information sharing and federated learning architectures aimed at anomaly detection. EASA regulation on information security needs to be taken as a baseline. The proposal shall demonstrate a thorough knowledge of past SESAR (or non-SESAR) activities on this field *(R&I need: cyber-resilience)*.

- **ATM digital transformation.** Research aims at advancing towards the digital transformation in ATM facilitating data exchange and decision-making thanks to innovative, unconventional and breakthrough solutions at all stages of the lifecycle, from research using open science frameworks, through to tactical and operational optimisation. Shared-information platforms and new IT tools and services will support optimised and interconnected services, providing real-time information to professionals and the travelling public and enhancing system resilience in the event of disruption and crisis. Improving resilience capabilities is key for increased safely level, the traffic control capacity should be preserved even in case of major failures especially in a contingency situation in order to maintain a business continuity of the infrastructures, being the system capable of seamless service provision through virtualization and delegation to other infrastructure elements providing reliable support to emergency management. Research also addresses the impact that the co-existence between diverse technologies within the ATM network may have. AI-based tools will enable optimised mobility offerings and travel options, especially in cases of disruption, allowing the system to remain operational at acceptably high-performance levels. The goal is to ensure that aviation reaps the benefits delivered by, for example, artificial intelligence (AI) and big data. While focused on the ATM dimension, proposals shall consider potential constraints imposed by other domains as well as collateral impacts of ATM research on other domains. Research scope includes the development of an exportable AI transversal platform that could be used in different ATC systems, supported by e.g., data platform capabilities, security and data ontology/governance aspects, graph neural networks (GNN), etc. (*R&I need: free flow of data among trusted users across borders).*

- **Enhanced techniques to empower NM operations.** This element covers improving data structure and data storage to empower big data exploitation and analytics in network manager (NM) operations. Research aims also at investigating how business intelligence strategies and technologies can be applied to improve the efficiency, stability and resilience of the network through data analysis of business information *(R&I need: free flow of data among trusted users across borders)*.

- **Innovation in route-charging schemes.** This research element addresses how the route charging and cost-recovery mechanisms should evolve in order to move towards a service oriented provision scheme and how to better connect technological innovation with the SES performance scheme. Previous exploratory research projects in SESAR (e.g. COCTA) have shown the potential of new trajectory pricing schemes to support a more flexible distribution of the demand. Proposals addressing this area may build on this previous research or propose other innovative charging schemes (e.g., modulation of charges). Potential ideas include lower charges in periods of low demand, discounts for early flight planning with route commitment (in order to promote the SESAR shared business trajectory (SBT) concept and enable better ANSP resource planning), overcharge for changes after filing flight plan, etc. Research shall address the definition of potential innovative incentive mechanisms. Research may also look into charging schemes that consider environmental penalties or rebates, e.g. higher charges for flights filing flight-plans with longer routes than necessary, rebates for flights accepting an NM-proposed re-route or flying at a flight-level different from what they requested. The research element addresses the integration of SES performance and charging schemes and SESAR performance framework (*R&I need: Regulations and standards*).

2.2.4.1.6 Topic HORIZON-SESAR-2023-DES-ER2-WA1-6: ATM Excellent science and outreach for multimodality and passenger experience

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions are expected to reduce the impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or to improve the aviation environmental footprint thanks to an improved gate-to-gate planning. Additional environmental benefits will come from alleviating congestion at and around airports by improving passenger flows (through predictability and single-ticketing), etc.;
- **Capacity:** the proposed solutions are expected to contribute to capacity through real-time multimodal passenger constraint information that, when shared at network level, will help to reduce, for example, departure delay;
- **Passenger experience:** the proposed solutions shall improve the passenger experience by sharing data on air transport with travel service providers to help passengers plan intermodal journeys that include air segments. Results are expected to demonstrate the viability of the integration of airports as multimodal nodes into the ATM network to enable interoperability between aviation and other modes of transport;

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- **Cost-efficiency**: the proposed solutions are expected to allow new 'as a service' businesses, based on new data-sharing standards and systems creating more value for aviation, within an integrated transport-system;
- **Operational efficiency**: improved, accurate, customer-focused planning, including user-driven prioritisation, allows operators to customise and optimise every flight, balancing their individual constraints against those of the network, with a direct positive impact on additional gate-to-gate flight time, fuel burn per flight, and operational costs from congestion and disruption.

Scope

Flightpath 2050, Europe's long-term vision document on aviation research, has set the goal that 90% of travellers within Europe should be able to complete their journey, door-to-door (D2D), within 4 hours by 2050. The challenge is to develop potential innovative and breakthrough solutions to meet this goal. The role of ATM in the door-to-door chain of a passenger's journey may seem small, but the punctuality of flights, and passengers' perception of flying, is highly dependent on the smooth functioning of the entire journey. Considering ATM to be an integrated part of an intermodal transport system, the proposed solutions will make it possible to share data between transport modes and to collaborate better to optimise the performance of both the overall transport system and the D2D journey.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the multimodality and passenger experience flagship:

- **Understanding passenger expectations.** Understanding passenger expectations (with regard to origin–destination, travel time, comfort, ecological impact and reliability, etc.) is a continuous activity linked to the flexibility/changes over time in demand for modes of transport. How can aviation monitor passenger expectations to improve its offer? How will changing passenger preferences shape the future multimodal transport system (e.g., airport products and services and the airport as a multimodal node)? *(R&I need: passenger experience at the airport)*.
- **Managing the passengers' access to airport**. Research aims at better understand and dynamically manage the arrival times of departing passengers at the airport. Research may consider medium/short-term predictions on the performance of different airport processes (both airside and groundside) and different factors: the operational situation at the airport (e.g., potential delays of the arriving flight (previous flight leg)), passengers' preferences, situation along the journey to the airport in different ground transport modes, etc. The potential solutions will propose the most suitable personalized time schedule before departure per passenger, as well as a recommended transportation pattern to optimise the passenger experience e.g., avoid queuing at the airport. Research may address the use of smart contracts and the benefits that could be derived from the access to airline information using privacy-preserving solutions*(R&I need: passenger experience at the airport)*.
- **Multimodal airport.** This research aims at evaluating the definition and impact assessment of new mobility solutions' (e.g., shared mobility) for a multimodal airport. Research may cover aspects such as airport access, the use of surface modes and

connected and autonomous vehicles to access the airport (including studying the trade-offs in terms of the environment, door-to-door travel time, etc.). The integration of UAM to intermodal airport solutions is also under scope (e.g., how multimodal access can help to enlarge an airport's catchment area, etc.) *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation)*.

- **ATM contribution to European Mobility as a Service (MaaS).** Research aims at developing ATM innovative solutions enabling passengers to transfer seamlessly between air transport and other transportation modes to reach the final destination quickly, smoothly, predictably, on time and without interruption (*R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation*). Research may address:
  - The application of consistent door-to-door oriented passenger rights to guarantee the journey reconfiguration if contracted services cannot be met, irrespective of the mode of transport;
  - The removal of the friction points for transferring between different modes of transport;
  - The connection between ATM to advanced urban and regional air mobility concepts;
  - Methods for predicting disruption in support of proactive mitigation and on suitable management and recovery mechanisms;
  - The application of trusted autonomy (TA) to improve the knowledge on how to code smart contracts where different passenger rights are coded. Access to airline information could allow to code and pay directly, insurance, cancellations, overbookings, etc.;
  - The integration and harmonization of data from disparate sources, their analysis and the generation of information and global learning.
- **Seamless connection between airports of all sizes, vertiports and heliports.** Research addresses potential solutions to enable simple, convenient, coordinated, safe and secure intermodal connections optimised for passenger experience. Research shall consider the EASA rulemaking task RMT.0230 about the introduction of a regulatory framework for the operation of unmanned aircraft systems and for urban air mobility in the European Union aviation system (*R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation*).
- **Digital twins for airports.** This research aims at developing an AI-supported concept of digital twin (DT) for airports integrated within the network of transport service providers to optimise the travel time and the overall network capacity and reliability, while minimising the environmental impact and achieving a fully scalable network. Research shall address the impact on airport operations and on safety in particular. Digital twins for airports consist of virtual models designed to reflect, accurate enough, a real airport. Several sensors located at the airport and related to vital areas of airport operations e.g., catchment area will generate relevant data to describe the real airport operations and performance e.g., passengers flows, aircraft turn around processes, etc. and the airport interaction with other modes of transport. Once informed with such data, the airport digital twin can be used to:
  - Develop synthetic simulation models, both for probabilistic predictions and full simulations with virtualized assets;

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- Create a what-if scenario generation capability for different operational use cases at the airport, influx of passengers, aircraft traffic, port and runway or access control systems, etc. and their impact on the airport catchment area;
- Generate different emergency / unusual scenarios both in the traffic at the airport itself (e.g., aircraft out of schedule, aircraft collision, any type of anomaly or malfunction, unauthorized traffic, different signals in the sensors and control and surveillance systems, terrorist attack at the airport, situations of maximum influx, adverse weather conditions, etc.) and in the airport catchment area to improve the different processes and services in those situations;
- Run what-if simulations and in particular, to assess multimodality use cases (e.g., how decisions taken at the APOC may influence the access/egress from the airport).

Research may study performance issues and generate possible improvements, all with the goal of generating valuable insights, which can then be applied back to the original physical object (*R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation*).

- **Information sharing and governance in an integrated transport network**. Research aims at investigating efficient ways for information transfer between transport operators as well as between transport operators and travellers. On top of the technical problems related with information sharing, one of the main issues to be addressed for the implementation of intermodal solutions is the lack of incentives and governance models (i.e. stakeholders need to perceive incentives to actually engage in coordination mechanisms). Research on governance and economic aspects is needed to address this problem. A sound governance model shall answer questions such as, for example, who is responsible for the information transfer between the service providers and the travellers and who should compensate the traveller in an intermodal trip if a connection is missed due to an unexpected disruption, which interoperable communication standard is used, etc. Research shall consider the ATM dimension of the problem, engaging with relevant ATM stakeholders (*R&I need: An integrated transport network performance cockpit*).
- **Mobility in the context of the European Integrated Transport Network**. The European transportation ecosystem is transitioning from individual modes of transport, through the concept of Integrated Transport System, towards that of Mobility. Mobility is defined as "the potential for movement and the ability to get from one place to another using one or more modes of transport to meet daily needs". As such, it differs from accessibility, which refers to the ability to access or reach a desired service or activity. There is, however, no harmonised concept for mobility, at least not in the scientific sense we normally use in Aviation. Even the European Mobility as a Service (MaaS4EU) project, the most advanced related coordinated research activity in Europe, does not aim to develop a generic "mobility" concept, but rather to prove the MaaS concept, defined as "A user-centric, intelligent mobility distribution model, in which users' needs are met via a single platform and are offered by a service provider, the mobility operator". Research aims at developing a harmonised concept for multimodal Mobility in the context of the European Integrated Transport Network (*R&I need: An integrated transport network performance cockpit*).

2.2.4.1.7 *Topic HORIZON-SESAR-2023-DES-ER2-WA1-7: ATM Excellent science and outreach for the aviation Green Deal*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions are expected to contribute to the achievement of the objectives of a 55 % reduction in greenhouse gas emissions by 2030 and net-zero greenhouse gas emissions by 2050, from a gate-to-gate perspective, by introducing new concepts enabling proper modelling of non-CO_2 emissions and their impact on optimum green trajectories, taking into account the expected interoperability with new entrants (i.e. U-space flights). The objective is not only limited to foster greenhouse gases reduction but also to reduce noise and air pollution;
- **Capacity:** the proposed solutions are expected to rely on high automation to reduce controller workload to improve capacity, which will then allow optimal and environmentally-friendly flight trajectories;
- **Cost-efficiency**: saving fuel for airspace users will reduce CO_2 emissions and related costs for emission allowances.

Scope

The European Green Deal has set the objective of net-zero greenhouse gas emissions by 2050, in line with the EU's commitment to global climate action under the Paris Agreement. To achieve this objective it is required to accelerate the shift to smarter and more sustainable mobility. The challenge is to achieve zero inefficiencies due to ATM by 2040: this means not only eliminating inefficiencies in the current system but also in the design and execution of the future ATM and U-space architecture. Proposals shall define and develop innovative solutions that could cover a wide variety of aspects e.g., operational measures that could be put in place to improve the fuel efficiency of flights, speeding up the modernisation of the air infrastructure to offer more capability and capacity and therefore offering more efficient trajectories, adapting the charging scheme to incentivise environmentally friendly operations, etc. The scope covers as well innovative ideas to accelerate decarbonisation of ATM and reduce the CO_2 and non-CO_2 emissions, through the integration of energy, transport and digitalisation platforms that are at the base of the green transition.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the aviation Green Deal flagship.

- **Atmospheric physics for aviation (non-CO_2) emissions, noise and air quality pollutants.** Further understanding of non-CO_2 effects (climate metrics) and associated uncertainties is needed. This element covers research to increase the body of knowledge on the physics of the atmosphere, to better understand the impact on global warming of non-CO_2 emissions (NO_x, SO_x, H_2O, particulate matter, etc.), including contrails and aviation-induced cloudiness. The non- CO_2 climate impact of aviation exhibits large uncertainties. Among others, they include the uncertainty in the meteorological forecast, the uncertainty associated to the calculation of climate effects and impact, the selection of the emission model, or the model parameterisations required for development of efficient MET services. Research should aim in particular to reduce the uncertainty associated with the radiative forcing effects of aviation emissions identified in the 2020

European Commission report on the non-CO_2 impacts of aviation ([40]). Investigate the relationship between atmospheric conditions at time of emission and subsequent non-CO_2 climate effects. Close coordination with EASA is expected, to ensure complementarity and consistency with EASA activities. Research may include:

- The definition of an adequate physical climate metric which is able to assess (quantify) climate effects of future emissions;
- The comparison in terms of quality of current meteorological forecasts, as well as of individual approaches presented so far by previous research initiatives e.g., FlyATM4E in order to provide a quantitative measure of the climate effects of aviation emissions, comprising contrail (cirrus) effects, NOx-induced effects, direct effects of water vapour emissions and aerosol induced effects;
- The evaluation of radiative transfer modelling, which determines climate effects of aviation emissions;
- The assessment of models of contrail life cycle and comprehensive chemistry-climate modelling involving representation of reactive species and aerosols, which influence radiative transfer in the atmosphere;
- Improve and systematically evaluate the quality of the weather forecast to represent those key meteorological fields, which are relevant for climate effects of aircraft emissions (e.g., upper tropospheric humidity, ice water content or representation of ISSR) as well as background concentration of reactive species;
- The quantification of impacts on non-CO2 effects from different blending ratios of different types of sustainable aviation fuel (SAF) (e.g., HEFA, FT-SPK, etc.);
- Explore possible options to evaluate and validate contrail formation and atmospheric conditions, by e.g., satellite products. This will allow gaining confidence in radiative effects induced, but also identify success of alternative routing strategies, which aim e.g., to avoid warming contrails as could be explored during live trials.

Research shall take into consideration the output of SESAR projects FlyATM4E, SINOPTICA and ALARM, and other non-SESAR projects, which outcomes are fully relevant on this research element e.g., ACACIA (research on transport patterns of nitrogen oxides NO_x) and ClimOP. In addition, research shall ensure coordination with project CICONIA funded under call HORIZON-SESAR-2022-DES-ER1.

Research also aims at increasing the body of knowledge on the impact of ATM on areas such as noise and air quality pollutants (nitrogen oxides (NO_X), particulate matter (PM), volatile organic compounds (VOCs), sulphur dioxide (SO_2), carbon monoxide (CO) and unburnt hydrocarbons (HC)). Research aims at better understanding the ATM environmental impacts beyond greenhouse emissions (CO_2 and non-CO_2 aviation emissions). In particular considering that in the near future there will be new types of aircraft propulsions, new aircraft configurations and new propulsion fuels (e.g., hydrogen), whose impact on noise and air quality need to be researched *(R&I need: non-CO_2 impacts of aviation)*.

([40]) https://www.easa.europa.eu/document-library/research-reports/report-commission-european-parliament-and-council

- **Noise and air quality pollutants.** Research aims at increasing the body of knowledge on the impact of ATM on areas such as noise and air quality pollutants (nitrogen oxides (NO_X), particulate matter (PM), volatile organic compounds (VOCs), sulphur dioxide (SO_2), carbon monoxide (CO) and unburnt hydrocarbons (HC)). Research aims at better understanding the ATM environmental impacts beyond greenhouse emissions (CO2 and non-CO2 aviation emissions). In particular considering that in the near future there will be new types of aircraft propulsions, new aircraft configurations and new propulsion fuels (e.g., hydrogen), whose impact on noise and air quality need to be researched (*R&I need: non-CO_2 impacts of aviation)*.

- **Comparative study on potential metrics to be adopted in the ATM domain to aggregate non-CO_2 and CO_2 impacts on climate change.** The study should cover, for example, global warming potentials (GWP) 100, average temperature response (ATR) 20, ATR 50, ATR 100, radiative forcing index (RFI) and alternative metrics, taking as a starting point the options outlined in the 2020 European Commission report on the non-CO_2 impacts of aviation. Proposals should include an initial task to review the state of the art of environmental metrics and engage with all relevant stakeholders in order to provide insights into the pros and cons of each potential metric, with the aim of formulating informed recommendations for the way forward, including the identification of additional research needs if applicable. This research should consider how metrics can be used in different contexts, for example for operational decision-making in the pre-tactical and tactical phases of ATFM, operational decision-making in real time by ATC, post-operations analysis and environmental performance monitoring at network level. Close coordination with EASA is expected, to ensure complementarity and consistency with EASA activities. In addition, the proposed climate metrics should be able to assess (quantify) climate effects of future emissions (and not only of historic emissions e.g., as done in the radiative forcing concept) by e.g., evaluating atmospheric response (temperature change) after a dedicated time horizon (e.g., 20, 50, and 100 years). Research shall take into account the output of project FlyATM4E *(R&I need: non-CO_2 impacts of aviation)*.

- **Atmospheric physics for aviation (extreme weather events).** This element focuses on climate resilience and adaptation, as it aims at increasing the body of knowledge on the physics of the atmosphere, to make it possible to better predict extreme weather events that may impact aircraft operations, and in particular cause airport closures or significant reductions in airport capacity (with knock-on effects on the network). The research should in particular consider the challenges for accurate prediction that may result from changes to weather patterns arising from global warming in the short to medium-term. Research may also address the knowledge gaps in the understanding of the links between long-term climate change and risks to the aviation sector required to achieve a coherent strategy and short-term decision-making. These gaps have been reported in the “ICAO CAEP aviation and climate change factsheet” and the "European aviation environmental report 2022”. It is important to address these long-term links to allow ATM become more resilient, and assure that ATM short term induced decision will not jeopardise long-term ATM resilience and sustainability (*R&I need: accelerating decarbonisation through operational and business incentivisation)*.

- **Environmental impact assessment methodology and new metrics.** It is necessary to develop further the methodology used in SESAR 2020 not only to cover the research phase, but also the deployment and implementation phases. As part of this methodology, the use of big data analysis and machine learning should be extended to the development of new environmental metrics that will be used to monitor environmental impacts and incentivise actors to promote compliance with environmental targets and regulations. These metrics will also be integrated into the environmental dashboard, and into the environment impact assessments toolset. Research shall consider as well the European Aviation Environmental Report. Research shall take into consideration the SESAR environmental performance assessment methodology (*R&I need: accelerating decarbonisation through operational and business incentivisation*).

- **Development of the environmental performance-monitoring toolkit to include new entrants.** There is a need to develop further the set of European environmental impact assessment tools, in order to analyse, inter alia, the integration of new entrants into the future ATM system and the overall environmental benefits and impacts they will have. This element covers the expansion of the ATM aircraft performance models (on emissions and noise) to include new entrants and new aircraft types/fuels. It involves research into the impact on the environment of new fuels and/or new aircraft types (hydrogen, electric, sustainable aviation fuels, new hyper-/supersonic aircraft (with consideration of sonic booms)), including the development of new models to assess the impact that ATM operational changes may have when these aircraft are introduced into the traffic mix. It should also include the development of methodologies to assess the environmental and societal impact of U-space-enabled drone operations, including in particular the identification of all potential impacts (e.g., visual pollution, noise over populated areas, intrusion into privacy, risks to wildlife (migrating birds, nesting areas, etc.)). Due to the complexity and diversity of environmental impacts, particular attention needs to be paid to the analysis of trade-offs, between environmental impacts, but also possibly with other performance areas *(R&I need: impact of new entrants)*.
- **Impact of zero-emission aircraft on ATM.** The advances in the development of electric and hydrogen-powered propulsive systems support the future vision of air transport without any direct carbon emissions, thereby contributing to the Green Deal goal. It is anticipated that hydrogen and electric-powered flights will carry lower payload and may have requirements for longer turn-around times. Their performance will also be different from that of conventionally powered aircraft. Their introduction will fundamentally change the traffic demand that will have to be managed by the ATM system. There is a need to define scenarios of future fleet composition, model the resulting air traffic demand, evaluate the reduction of the environmental footprint enabled in each of the scenarios (considering direct and indirect emissions), analyse the implications of these changes on the airspace structure and the ATM system, and outline potential solutions for their adaptation. It is also relevant to explore the implications for airline operations that may impact ATM processes e.g., longer turnaround/airline scheduling, new flight planning/flight plan acceptance processes. New network management processes and changes to airport capacity also need to be considered. The research shall be tightly focused on the ATM dimension; impact of ATM on other relevant domains, or impact of ATM constraints on other domains may be addressed, but this should not be the core objective of the project. Integration of the new aircraft models into ATM models is in scope, but development of aircraft/propulsive systems and/or aircraft/propulsive system models is out of scope (the research should use aircraft/propulsive system models developed prior to the start of the project). The goal of this research is to inform policymakers, industry leaders, and researchers about the

potential R&D needs to allow the safe integration of zero emission aircraft in the ATM system *(R&I need: impact of new entrants).*

- **New forms of air traffic management.** Research aims at exploring new forms of air traffic management to support the integration of highly automated vehicles and autonomous aircraft e.g., high altitude platform systems (HAPS), aircraft with new propulsion systems (electric/hydrogen), unmanned aircraft systems, recreational flying vehicles and other new entrant operators while minimising their environmental impact, in terms of greenhouse gases emissions, noise and air pollutants. Research shall take into consideration the variety of vehicle performances and their impact on traffic management (*R&I need: impact of new entrants*).

2.2.4.1.8 *Topic HORIZON-SESAR-2023-DES-ER2-WA1-8: ATM Excellent science and outreach for Artificial Intelligence (AI) for aviation*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions shall have a positive impact on the environment (i.e. in terms of emissions, noise and/or local air quality) and on the aviation environmental footprint e.g., AI will enable the optimisation of aircraft trajectories;
- **Capacity:** AI will play a fundamental role in aviation/ATM to address airspace capacity shortages, enabling dynamic configuration of the airspace and allowing dynamic spacing separation between aircraft;
- **Operational efficiency:** the proposed solutions are expected to improve the synchronisation and predictability of the ATM system;
- **Cost efficiency:** AI will enrich aviation datasets with new types of datasets unlocking air/ground AI-based applications, fostering data-sharing and building up an inclusive AI aviation/ATM partnership**;**
- **Safety:** the proposed solutions are expected to maintain at least the same level of safety as the current ATM system;
- **Security:** the proposed solutions are expected to maintain at least the same level of security as the current ATM system.

Scope

Tomorrow’s aviation infrastructure will be more data-intensive and thanks to the application of Machine Learning (ML), deep learning and big data analytics aviation practitioners will be able to design an ATM system that is smarter and safer, by constantly analysing and learning from the ATM ecosystem. Artificial intelligence (AI) is one of the main enablers to overcome the current limitations in the ATM system. AI is a breakthrough technology that could radically influence or transform the aviation/ATM industry value chain, potentially impacting all stakeholders, including original equipment manufacturers (OEMs) and their business models. The impact of transformative AI will be felt throughout the industry, and beyond. The challenge is to develop potential innovative and breakthrough AI solutions that will help addressing capacity issues in ATM by enabling better use of data, leading to more accurate predictions and more sophisticated tools, increased productivity and enhancing the use of airspace and airports. Considering the extent of these challenges, the proposals shall define and develop potential innovative AI-based solutions that may come up with innovative responses based on non-straightforward correlations of parameters, while improving the scalability, efficiency and resilience of the system.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the AI for aviation flagship.

- **AI for higher automation.** This element covers the development of an AI-powered infrastructure and services (supporting higher levels of automation). In addition, the aim is to develop automation of ATM processes in which analysis and prediction are particularly likely to benefit from AI, and to develop AI-powered ATM environment requirements, infrastructure, and common regulation and certification guidelines. This may include the research on multi-agent deep reinforcement learning (RL) that has a great potential to enable a highly automated ATM, where functions, roles and tasks are allocated to human and artificial intelligence-based agents at both ground and airborne side based on the strengths and weaknesses of each type of agent. Research shall take into account the impact on the role of the human, responsibility and liability aspects, etc. *(R&I need: human–AI collaboration: digital assistants)*.
- **Exploring underuse AI paradigm in ATM.** AI Paradigms (X-axis) are the approaches used by AI researchers to solve specific AI-related problems. Without trying to be exhaustive, a broad classification accounts for: logic-based tools, knowledge-based tools, probabilistic methods, machine learning, embodied intelligence, search and optimization. Latest projects applications have concentrated most of the research efforts on application of ML in ATM, in detriment of exploring the possibilities of what the other paradigms could do for ATM. Research aims at investigating these alternative possibilities (*R&I need: human–AI collaboration: digital assistants*).
- **Transfer-learning and few-shot learning methodologies in ML ad XAI.** Research focuses on transfer-learning and few-shot learning methodologies. In ATM domain, the transfer-learning methodology could be another essential research and development direction for utilizing machine learning and XAI. The lifelong machine can incorporate transfer learning for parameterizing to learn domain-invariant features (e.g., how existing AI models can be used for solving different tasks that share common features or attributes). Transfer-learning can also be used where there are some relations between ATM tasks, such as balancing arrival and departure capacity and take-off delay prediction. Few-shot learning (FSL) is a machine learning framework that enables a pre-trained model to generalize over new categories of data (that the pre-trained model has not seen during training) using only a few labelled samples per class e.g. models for the detection of objects in an image, etc. Research on this element shall consider the output of project ARTIMATION *(R&I need: human–AI collaboration: digital assistants)*.
- **Innovative methodologies for ATM safety, security and resilience.** Research aims at developing methodologies (or evolution of existing ones) for safety, security and resilience that will contribute to ensure that ATM is robust against ever-evolving risks, threats and disruptive events in the physical and cyber worlds in an environment with

automation levels 4/5. New and disruptive technologies, operations and business models to ensure ATM is resilient against internal and external threats, including health, natural disasters, terrorism and criminal activity. Research shall ensure coordination with EASA (*R&I need: trustworthy AI-powered ATM environment*).

- **Ensuring the integrity of non-ATM data for AI/ML applications in ATM.** For artificial intelligence and machine learning applications in aviation the integrity and quality of input data is critical. The benefits of AI in ATM can only be leveraged if the models are fed with great quantities of good quality data. While existing ATM data present certain homogeneity and is, by design, oriented to ATM uses and analysis, other data sources also needed for the development of AI models in ATM are heterogeneous and not adapted to ATM granularities. One example is meteorological information, which is presented in a variety of sources and formats that are not always of direct use in ATM solutions. There is a need to develop potential solutions to identify erroneous data injected from non-ATM sources that could introduce a safety risk in ATM and how to mitigate it. The research shall address these non-ATM data availability and format, proposing a framework for data curation, sharing and feeding oriented to ATM use cases, as well as developing new indicators at least for data quality and integrity (*R&I need: Trustworthy AI-powered ATM environment*).
- **Enhancing robustness and reliability of machine learning (ML) applications.** Research aims at enhancing machine learning (ML) applications to ensure they are technically robust, accurate and reproducible, and able to deal with and inform about possible failures inaccuracies and errors. Research aims at developing potential solutions to address this challenge, which shall include/refer to the EASA methodologies for certification of AI in aviation. The scope may address:
  - Verification methods of robustness for machine learning (ML) applications. Due to the statistical nature of machine learning applications, they are subject to variability on their output for small variations on their input (that may even be imperceptible by a human). Research aims at proposing new methods to verify the robustness of machine learning applications, as well as to evaluate the completeness of the verification;
  - Standardised methods for evaluation of the operational performance of the machine learning (ML). Research addresses the definition of **r**eference methods and metrics to assess the accuracy or error rate of ML applications;
  - Application of transfer learning and data augmentation techniques for the development of the proposed applications, thus guaranteeing their robustness. In addition, these systems would be continuously validated using ML Ops methodology and explainability techniques, to ensure system performance and detect as early as possible if concept drift is occurring;
  - Identification, detection and mitigation means of bias in ML applications. Machine learning applications are subject to bias, which can compromise the integrity of their outputs. One of the most challenging aspects when collecting, preparing or using data, is the capability to identify, detect and finally mitigate adequately any bias that could have been introduced at any time during the data management and/or of the training processes. Research aims at developing potential solutions to address this challenge (*R&I need: trustworthy AI-powered ATM environment*).

- **Accelerating AI implementation for ATC automation.** AI implementation pace in ATC is far slow compared to other industries. Safety is the principal barrier in the ATC context. Research aims at developing concrete applications that can support the acceleration of AI implementation in Europe. The research seeks for environments where full (or close to full) ATC automation may become a reality in the short term without human supervision. Those scenarios could be very low complex situations like night shifts, where few flights need ATC service are the most suitable, but the research should explore the suitability of more complex scenarios. Research also addresses exploratory activities on solutions non-dependant of human supervision to take back control to solve contingency is necessary. Research may propose ML-based potential solutions to address specific operational use cases, relying on explainability techniques to validate the robustness and performance of the system in all types of situations(*R&I need: Trustworthy AI-powered ATM environment*).
- **Just culture and AI**. Before the introduction of AI/ML into the ATM system, it was difficult but possible to draw the red line between “gross negligence”, “wilful violations” and “destructive acts” on the one side and “honest mistakes” on the other side. State of the art algorithms for AI/ML systems such as neural networks are essentially “black boxes” in terms of explainability. Arguably, the best-known disadvantage of neural networks is their “black box” nature. Simply put, it is unknown how or why the neural network came up with a certain output given a certain input. In other words, they are tremendously successful in providing accurate predictions based on historical data, but no one can understand why. The introduction of AI/ML in essence clouds the drawing of a red line between “gross negligence”, “wilful violations” and “destructive acts” on the one side and “honest mistakes” on the other side. Research aims at redefining just culture and rewrite its procedures in the era of digitalization (*R&I need: Trustworthy AI-powered ATM environment*).
- **Development of ATM specific ontologies**. This research element focuses on special-purpose representation systems (e.g., semantic networks and description logics) that can be devised to help organizing a hierarchy of ATM related categories. There are many variants of semantic networks, but all are capable of representing individual objects, categories of objects, and relations among objects. Knowledge representation through a semantic network will enable ATM-related knowledge to be expressed not only in natural language, but also in a format that can be read and used by software agents; hence, permitting them to find, share and integrate information more easily *(R&I need: AI Improved datasets for better airborne operations)*.

2.2.4.1.9 Topic HORIZON-SESAR-2023-DES-ER2-WA1-9: ATM Excellent science and outreach for civil–military interoperability and coordination

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Civil–military coordination:** the proposed solutions are expected to improve civil–military coordination at Network level, with shareable data on mission trajectories for better traffic prediction and airspace information exchange;
- **Capacity, operational efficiency and environment**: the additional predictability resulting from the integration of military flight data into the network, will lead to more

efficient use of available airspace capacity by civil traffic which will lead to fewer delays, which will lead to greater fuel efficiency;

- **Security:** while ensuring better coordination, the proposed solutions will also ensure that the new data formats and information exchange services guarantee at least the current level of confidentiality, integrity and availability of information.

Scope

The Digital European Sky vision requires a sufficient level of civil/military interoperability and coordination, especially concerning trajectory and airspace information exchange, as well as the use of interoperable CNS technologies. The challenge is to identify and develop innovative solutions that could help achieving the appropriate level of civil-military interoperability, also maximising synergies between civil and military research and development activities.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the civil–military interoperability and coordination flagship:

- **Enhancing civil–military operations.** Based on a survey of the existing procedures and services, this element will aim to identify new challenges related to the development of CDM processes for improved civil–military coordination, covering both manned and unmanned military remote piloted assets of all categories (e.g., large MALE-type RPAS, hybrid/heterogeneous formations, drone swarms, etc.). Research also addresses enriched military surveillance and threat detection based on big data analysis as well as potential impacts of military assets at different altitudes (from small drone swarms for low altitudes to HPAs for high altitudes). The research will investigate procedures, data formats (including the necessary levels of cybersecurity and data protection), and the application of resilience engineering across civil military ATM applications, dual-use technologies and information exchange services. An assessment of the relevant performance measurements will also carried out. Research aims also at tackling different standards in design of both military and civil aerodromes *(R&I need: access to airspace)*.
- **Access to airspace.** To improve mission effectiveness for all types of manned and unmanned vehicles, military access to airspace must be guaranteed for planned and unpredictable trajectory profiles. In that regard, high-level civil–military ATM interoperability is fundamental, and this can be achieved through civil–military CDM supported by common procedures, data formats and underlying information exchange services. New systems and procedures should be flexible enough to adapt to different operational scenarios and needs, and ensure optimal separation management taking into account different and coexistent CNS air and ground capabilities. This is a precondition for accommodating civil and military operations in the same airspace *(R&I need: access to airspace)*.
- **Fully automated FUA process.** Research aims at developing potential solutions for a fully automated FUA process able to accommodate military needs supported by higher levels of automation and to address the challenging demands for more airspace that come hand-in-hand with the introduction of new generation of military aircraft, and the inclusion of UAS into controlled airspace (*R&I need: access to airspace*).

- **ATM civil-military interoperability in support of disaster/crisis management.** Due to the multitude of actors involved, disaster management represents an enormous challenge in terms of information exchange and the coordination of civil and military forces. Research aims at developing potential solutions to advance civil-military interoperability through the design and development of easy-to-use, digitally supported information exchanges to better manage, from the ATM perspective, potential crisis and/or disasters. Research may address the development of a reference integration framework capable of ingesting data from heterogeneous sources in real time, processing, harmonizing and treating the information and exposing it to the different actors in emergency situations or possible crises (*R&I need: Access to airspace*).
- **Performance management.** Environmental sustainability, cost-efficiency and delays resulting from inefficient use of available capacity are concerns that all aviation stakeholders are responsible for addressing. The complex interdependencies between civil and military stakeholders need to be examined to enable appropriate performance measurement in a spirit of balanced consideration between national security and defence requirements (including potential non-negotiable ones as defined by the States), financial feasibility and commercial needs *(R&I need: performance orientation)*.
- **Development of innovative civil-military cooperation and coordination indicators.** Civil-military cooperation indicators available in the SESAR performance framework allow a limited assessment of the improvement of civil-military coordination concepts in terms of civil and military flight efficiency the effectiveness of the coordination processes. Research aims at developing these indicators and/or propose new innovative ones. In addition, research will contribute to better understand the apportionment of SESAR ambition to increase flight efficiency between projects working on the improvement of civil-military coordination processes and projects working in other areas *(R&I need: performance orientation)*.
- **Digitalisation for airspace management (ASM) and mission trajectory management (MTM).** Digitalisation for ASM and MTM will allow better integration of military requirements within ATM network operations. This enables the optimisation of trade-off between operational efficiency, flexibility and predictability of operations. Cloud, big data technologies and machine learning algorithms to allow exploiting conventional ATM data, and non-conventional data (video and voice records, passengers' information, etc.) to make accurate predictions of the impact of different airspace and mission design and management options, thus supporting the relevant decision making processes. Research also addresses the potential application of predictive algorithms and statistical techniques for the exploitation of data in the cloud and relational and non-relational big data techniques with the aim of creating AI models, extracting information and exploiting the results in ASM and MTM. This will allow decoupling the provision of technical capabilities from the technical infrastructure necessary to provide services (*R&I need: performance orientation*).
- **Improved security of military operations.** This research element covers two separate aspects of protecting aviation data confidentiality: anonymization and confidentiality. Confidentiality refers to the protection of sensitive information in military air operations, both in training and real-world scenarios, to safeguard against adversaries and open-source intelligence. Confidentiality and anonymization both play important roles in ensuring the security and protection of military aviation data and should be addressed collectively. During peacetime, safety imperatives dictate that aircraft must

remain cooperative with the underlying surveillance infrastructure but military operations may need to conceal the status and identification of flights. Some mitigating measures are possible for military operations deemed sensitive in nature e.g., Head of state flights but research is needed to develop more permanent technical solutions to address these security shortcomings. For air/ground systems like ADS-B or data link, the main security concerns are the exploitation of real-time airborne position data by malicious attackers. Another potential vulnerability is the possibility of generating false but credible ADS-B reports or data link messages, providing ghost aircraft tracks and thus confusing ATC (spoofing). Possible measures to mitigate this type of vulnerability include the suppression or concealment of information, message authentication, and/or increased monitoring activities of suspicious messages. More research is needed to speed up the response time to remove any intruder of false ADS-B signal out as fast as possible. Anonymization involves the use of various techniques, including data generalization, masking, pseudo-anonymization, synthetic data, shuffling, and perturbation, to remove or obscure personal information from data. The use of AI and other disruptive technologies can also enhance the effectiveness and automation of the anonymization process. Research on this area shall take into consideration the work done in industrial research solutions PJ.14-W2-84c “Secured surveillance systems (single and composite systems)” and PJ.14-W2-84d “Phase Overlay for ADS-B”. (*R&I need: connectivity and access to CNS infrastructure*).

2.2.4.2 *Work Area 2: ATM application-oriented research (Research and Innovation actions)*

Applied research includes exploratory research activities that aim at bridging the results of ATM excellent science and outreach activities and industrial research activities i.e. applied research develop potential solutions that have already successfully achieved TRL1 either within SESAR programme or outside. Applied research activities will develop innovative and breakthrough solutions, at least, to the level of maturity required to feed the next step in the R&I pipeline i.e. industrial research.

Specific conditions for WA2	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 2.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 16.00 million
Type of actions	Research and innovation action (RIA)
Procedure	The procedure is described in General Annex F to the Horizon Europe work programme for 2023–2024. The following exception applies: to ensure a balanced portfolio, grants will be awarded to applications not only in order of ranking but at least also to those that are the highest ranked within topics within the same work area, provided that the application attains the threshold.
Legal and financial set-up of the grant agreement	Grants awarded under this work area will have to submit the following deliverables: • Exploratory research report (ERP) • Exploratory research report (ERR) • Functional requirements document (FRD) • Operational services and environment description (OSED) • Economic evaluation (ECO-EVAL) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 3 months after signature date and periodically updated)

2.2.4.2.1 Topic HORIZON-SESAR-2023-DES-ER2-WA2-1: ATM application-oriented research for connected and automated ATM

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions should have no negative impact on the environment (i.e. in terms of emissions, noise and/or local air quality) or on the potential improvement of the aviation environmental footprint;

- **Capacity:** the proposed solutions are expected to contribute to capacity by enhancing the management of separation minima, both for en-route airspace and the TMA, and the provision of additional meteorological services. At airport level, the solutions will enhance the calculation of arrival runway occupancy times and the resilience of runway throughput to meteorological disruptions, enhance departure queue management, improve visual separation procedures for the aerodrome circuit and support fully automated airport operations through improved predictability;
- **Cost-efficiency:** the proposed solutions are expected to justify the investment costs related to the adoption of automated technologies and tools;
- **Safety:** The proposed solutions are expected to maintain at least the same level of safety as the current ATM system, with higher levels of automation, especially through the identification of negotiation-based resolutions at conflict resolution and collision avoidance levels, safety nets for new separation modes and improved approach procedures into secondary airports in low-visibility conditions;
- **Security:** The proposed solutions are expected to identify and mitigate the potential security risks deriving from having a more interconnected and automated ATM system.

Scope

The challenge is to design and develop concrete innovative applications (that are already TRL1, achieved within SESAR programme or outside) that aim at increasing the level of automation and connectivity of the future ATM ground system and make these applications ready to transition towards industrial activities in future DES calls. The future architecture of the European sky will rely in an increased level of automation: the proposed innovative solutions shall aim at achieving between level 4[41] and level 5[42] in all operating environments, including the transition areas between Europe and neighbouring ICAO regions, which may have specific regulations and challenges. Higher levels of automation are considered an essential enabler for increasing the performance of the ATM system, enabling numerous actors to interact with each other seamlessly, with fewer errors making the system scalable and even safer than today. Proposals may take up the challenge to develop innovative solutions for an affordable and service-oriented way of sharing trajectories across ATM actors, enabling the capacity, cost efficiency, operational efficiency and environmental performance ambitions of the European ATM Master Plan for controlled airspace and airports. To realise the SESAR vision, innovative solutions to increase the level of connectivity between all components of the ATM infrastructure will be required i.e. hyper connectivity between all stakeholders (vehicle-to-vehicle, vehicle-to-infrastructure) via high bandwidth, low-latency ground-based and satellite networks.

The SESAR 3 JU has identified the following innovative research elements that could be used to meet the challenge described above and achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the connected and automated ATM flagship:

- **Increased automation in core En-Route/TMA ATC functions**. The objective of this research element is to develop core functions of en-route/TMA ATC centres aiming at

[41] Automation supports the human operator in information acquisition and exchange, information analysis, action selection and action implementation for all tasks/functions. Automation can initiate actions for most tasks. Adaptable/adaptive automation concepts support optimal socio-technical system performance.

[42] Automation performs all tasks/functions in all conditions. There is no human operator.

automation levels 4 / 5 (as per the ATM Master Plan). Research may propose operational concepts and concrete applications that will support the evolution of en-route/TMA ATC from executive to supervisory control (e.g. delegation of control to the automation). Research shall address the challenges on the role of the human to ensure that the proposed applications are fully consistent with human capabilities and the specific challenges that hinder the application of machine learning / artificial intelligence methods for the further automation of ATM (e.g. transparency, generalisation, etc.). Research shall take into account the recommendations provided by the "expert group on the human dimension of the Single European Sky". Research may address the impact on the roles, the definition, responsibilities and tasks of the different actors e.g. ATCOs, FMPs, ATSEPs, supervisor, etc.), their training needs and other important aspects such as e.g., liability, certification aspects, etc. in an environment with higher levels of automation *(R&I need: advanced separation management)*.

- **Sector-less ATM**. This research element aims at developing a sector-less concept, which considers all the entire upper airspace of the ECAC states as one single airspace and therefore, foresees the elimination of existing country boundaries and all sector boundaries within them. Research may evaluate the needs of advanced AI/ML-based tools (corresponding to automation levels 4 and/or 5) and the evolution of existing capabilities (e.g. evolution of the CWP HMI to consider larger airspaces, wide area communications, etc.) to support the concept in such wide area. Research may address how the concept will impact the current structure of the Air Navigation Service Providers (ANSPs), which will no longer be responsible for a specific national territory, but for aircraft flying across the entire ECAC airspace and explore potential alternatives to the conventional ANSPs *(R&I need: advanced separation management)*.
- **Evolution of flight-rule concepts, separation management service concepts and airspace classification.** This element covers the potential evolution of responsibility for separation provision in an environment where advanced detect and avoid (DAA) and electronic conspicuity systems are fitted to majority – but not all - of participating traffic. Research should cover, individually and collectively, the role of the separator and the mode of separation provision; the need for and possible updates to or renewal of the airspace classification system; the definition and potential renewal of flight rules for manned and unmanned aircraft systems; and a potential review/qualification of the need for visual flight rules (VFR) flights to remain in visual meteorological conditions, including the need to remain clear of cloud, given the existence of advanced electronic systems that replace and/or augment the performance of the human eye. The research must assess the impact on all current airspace users, including main airlines, business aviation, general aviation, sports aviation and military aviation, as well as considering the impact on new entrants (both drones flying low and manned or unmanned aircraft systems flying at high altitude) *(R&I need: advanced separation management)*.
- **Use of advanced meteorological information and capabilities** (*R&I need: advanced separation management)*. This research covers the needs to:
  - incorporate ensemble weather information into decision support tools that can be adapted for different ATM stakeholders;
  - produce very high-resolution, very short-range weather forecasts using numerical weather prediction models and observational data assimilation;

  - share very short-range weather forecasts based on Aircraft Meteorological Data Relay and observational data assimilation (e.g., predicted wind, wind shear) during the approach and landing phases, Mode-S EHS, new possibilities emerging form ADS-C, etc. The research also covers the novel avionics and flight crew procedures required to use this information.

- **Ionosphere gradients monitoring and Space Weather Forecast.** This element covers monitoring and forecasting of ionospheric conditions to enhance GNSS positioning and improve the availability of augmentation systems (GBAS, SBAS) used in aviation. Most aircraft are equipped with GNSS receivers using GNSS position solution as an alternate surveillance tool in combination with other means (DME, VOR, NDB, INS, LDACS A-PNT, etc.). It is expected that, in the future, GNSS will be more frequently used for determining geometric altimetry as an alternative to barometric altimetry. Using data fusion technique, future ATM applications will combine data collected by the vehicle's own sensors as well as ground- and space-based augmentation techniques (e.g., exploiting multi-constellation GNSS). However, GNSS signals may be disturbed, attenuated or even lost due to severe space weather activities with impact on the ionosphere. Monitoring and forecasting ionospheric conditions and gradients is therefore needed to calculate exact GNSS position for navigation as well as in the determination of geometric altimetry. Furthermore ionospheric gradient information is crucial to assess the availability of augmentation systems (GBAS, SBAS) used in aviation *(R&I need: advanced separation management)*.

- **Traffic allocation to arbitrary flight levels.** This research aims at enabling aircraft to fly at any arbitrary flight level, as optimised by aircraft performance, weight and atmospheric conditions. Even/odd cruise level assignment should be based on traffic supply, rather than on the semi-circular rule (also known as the hemispheric rule). The results should enable the use of all flight levels in the European one-way 'trunk routes' concept *(R&I need: advanced separation management).*

- **Evolution of separation minima**. The scope of the research includes investigating advanced modes of separation (e.g. dynamic separation) based on predictive modelling and ML techniques and enabled by further automation and improved connectivity. In addition, the dynamic calculation of the necessary separation parameters between aircraft (horizontal and vertical) to meet a minimum acceptable safety level (i.e. moving away from pre-determined separation standards) for en-route and TMA airspace should be addressed. The separation minima to be developed include both minimum radar separation (MRS), which aims to keep the risk of collision sufficiently low to meet the target level of safety (TLS), and minimum wake separation (MWS), which aims to keep the risk of wake encounter sufficiently low to meet the TLS and potentially provide safety benefits. The separation to be applied in operations will always be the maximum of the applicable MRS and MWS. The operational improvement will also require combined separation minima and consideration of flight-specific data *(R&I need: advanced separation management)*.

- **Adaptation of ground and airborne safety nets to new separation modes.** This element covers advanced separation management that will require close conformance monitoring of the negotiated and authorised flight trajectories throughout the execution phase, so that operations are not disturbed by unnecessary resolution advisories, in particular if lower separation minima are introduced/considered. Consideration of the level of independence of safety nets from other aspects of control will be critical, as the levels of autonomy automation of detection, classification, resolution and monitoring of conflicting profiles in the planning and tactical phases of ATM will significantly increase *(R&I needs: integration of safety nets (ground and airborne) with the separation management function)*.

- **Space-based multilateration.** This element covers space-based multilateration through ranging by satellites already used for space-based VHF or ADS-B systems, with preference given to those used for space-based ADS-B, as this could serve to cross-check the GNSS position acquired through ADS-B (in the same way that Mode S radar has a double check). Research may cover the specific challenges for active and passive spaced-based multilateration (e.g., synchronization, interoperability analysis with ground systems, etc.). The development of an integrity parameter for space-based ADS-B downlink to ground system should also be covered. Research shall address how to integrate the space-based multilateration in the context of performance based communication and surveillance (PBCS) concept *(R&I need: enabling the deployment of a performance-based CNS service offer)*.
- **Use of dedicated 5G network for complex low altitude operations.** Research addresses the potential use of a dedicated 5G network customized for complex low altitude operations (e.g., airports and their terminal areas, vertiports, logistic hubs, highly populated urban areas) supporting CNS requirements of safety critical applications. The potential solutions may be applicable to U-space, airports, vertiports, uncontrolled & controlled airspace with complex UAS and UAM operations. Research may address the possibility of sending local GNSS augmentation corrections through the 5G network. . Since the solution may be potentially very expensive, research shall address business case aspects considering that there are other potential alternatives e.g., LDACS. A coordinated approach with regulators and European institutions to overcome the issue that potential air traffic applications currently do not represent sufficient business motivation for network operators to implement additional features of 5G specs. Research shall consider the work done by GUTMA (Global UTM Association) and GSMA (GSM Association) to standardize some 5G protocols applicable to U-space *(R&I need: enabling the deployment of a performance-based CNS service offer)*.
- **Potential use cases and applications of LDACS for other airspace users (e.g., GA, U-space, Innovative Air Mobility).** The objective is to research the potential application of LDACS datalink / voice infrastructure (delivered at TRL6 for schedule / business aircraft in industrial research) focused on other airspace users e.g., GA, U-space, etc. The research shall address the definition of operational use cases, which should also take into consideration U-space and Urban Air Mobility areas (*R&I need: enabling the deployment of a performance-based CNS service offer*).
- **Alternate surveillance (A-SUR).** Alternate surveillance builds on the idea that the position known by an aircraft through whatever means (e.g., GNSS, DME, VOR, NDB, INS, LDACS A-PNT, etc.) can be downlinked through whatever datalink is available (e.g., SATCOM, LDACS, VDLM2, Hyperconnected 4G/5G/LTE, Mode S, ADS-B, etc.) to be used as back up for surveillance. Therefore, on the ground it is made available in ASTERIX format in case the primary surveillance are not available. Alternative means of surveillance can be also explored (e.g., high-resolution video images, etc.). Research addresses:
  - The definition of initial performances that the alternative downlinks should have to comply with (within the context of PBCS framework);

  - The design of innovative data fusion and predictive algorithms (e.g. based on ML) to integrate very heterogeneous data sources;
  - The analysis of the integrity of the data in case of operational use.

Technical enablers, expected performances and architectures to include this data in the surveillance chain should be analysed. In addition, cost analysis for different alternatives for A-SUR should be part of the research (*R&I need: enabling the deployment of a performance-based CNS service offer*).

- **Trajectory advisories.** Research aims at developing automated applications that could provide trajectory advice (including uncertainty considerations and improved weather forecasts) to ATCOs either for human confirmation or for automatic implementation. This trajectory advice could consist of a ranked list of trajectory options based on different optimization criteria (e.g., optimising cost, minimising environmental impact, etc.). For elaborating these trajectory advisories, the automated application shall assure separation and consider a variety of other operational constraints (e.g., ad-hoc downstream and pilot requests or non-conformance, continuous descent and arrival management demands, downstream airspace availability and workload, AUs business needs and equity, the evolution of certainty over the prediction horizon, ATCO preferences and ensuring workflow integration and redundancy and safe degradation, etc.). Research includes the analysis on the uncertainty spread of airport take-off times, as those uncertainties ripple forward into the downstream ATC sectors, influencing significantly on any ATC related resolution and automation support tool. Research may use operational data and/or "intermediate" operational data (from demonstrations, shadow mode trials, simulations, etc.) to build a wide catalogue of non-nominal situations to help dimensioning the level of uncertainty at various operational stages and prediction look-ahead times (*R&I need: network-wide synchronisation of trajectory information*).
- **Innovative applications for improving traffic synchronization.** Research aims at developing innovative applications for queue management in ATM, thus optimising airport and TMA throughput and reducing the environmental impact of ATM. The data-integration between arrival and departure managers, A-CDM parties and TBS tools, to allow the dynamic optimisation of runway use based on prevailing operational needs is also under scope (*R&I need: intelligent queue management*). This may include the enhancement of:
  - Extended AMAN capabilities e.g. the transfer of the predicted arrival holding times from the TMA to the upstream airspace or airports to reduce holding, the use of ML and AI for the refinement of AMAN algorithms, the use of weather data, by taking into account more efficient spacing through incorporation of satellite-based navigation techniques (ABAS, SBAS, GBAS), etc. Regression algorithms could be used (e.g. state of the art techniques such as transformer-based networks) to reduce possible errors made in the AMAN algorithm, etc.;
  - Departure queue management e.g. through further automation and exchange of highly accurate trajectory information between all actors (i.e. airports, ANSPs and aircraft operators). ML and AI could be used (but not only) to monitor differences between DMAN sequences and their implementation, in order to improve DMAN sequencing algorithms, improve pre-tactical planning, etc. Classification and

regression models could be implemented using the monitoring of the DMAN sequences to improve their accuracy;

- Coupled AMAN–DMAN functions e.g. by using improved algorithms e.g. based on ML and AI techniques to identify the most appropriate departing aircraft to make use of an arrival gap. The integration with other airport systems will ensure that the departing aircraft is loaded in a timely manner and taxies to the right place at the right time to be ready to take off. Ranking models could be implemented to determine the best aircraft based on arrival gap, aircraft waiting time, and other environmental conditions.

- **Automated provision of optimised trajectories during airport ground operations for all aircraft, vehicle drivers and tugs**. This research addresses different optimization criteria e.g., delays, environmental impact, etc. for all aircraft, vehicle drivers and tugs during airport ground operations. The proposed solution should aim at providing optimised trajectories before the execution of taxiing operations, monitoring the executing of these operations, and re-planning when deviations from the initial plans are detected. Research includes the suitability of the multi-agent systems for degraded conditions too i.e., situations with low-visibility conditions, changing weather and weather extremes, etc., and its robustness when human roles are in the loop. Research shall take into account the output of project AEON (*R&I: airport automation including runway and surface movement assistance for more predictable ground operations*).
- **Improved aircraft protection on the airport surface.** Research focuses on the development of advanced capabilities to support the flight crew to protect the airframe and decrease collision risk with nearby mobiles or fixed obstacles when moving on the airport surface (e.g., thanks to radar system generating alerts when the aircraft is getting close to mobiles/obstacles). The airport moving map and ATSA-SURF might not be sufficient to prevent collision with nearby mobiles (e.g., A380 incident at John Fitzgerald Kennedy airport) or fixed obstacles (e.g., A380 incident at Le Bourget air show). Safety is improved as this will help to avoid common accidents on the airport surface that often cause serious damage to the aircraft wings. This will also avoid disturbances cause by aircraft incidents on the airport operations (*R&I: airport automation including runway and surface movement assistance for more predictable ground operations*).
- **AOP and performance monitoring for a group of airports.** Research address the development of a single AOP to address the needs of a group of airports with similar operational needs that are too small to have their own AOP. This AOP combines information from each individual airports in order to meet collaboratively agreed joint targets for the group of airports, but taking into consideration individual airport needs and situation. The coordination among airports should always align and never compete with the overall airport-network view. Research also address the collaborative process for the definition of performance targets agreed for any set of airports that decide to gather under such a common AOP. The wider neighbouring community will participate in this process. The benefit of joint target setting will be the ability to set more challenging targets for a group of airports than would be possible for a single airport, thus providing improved service to the Airspace Users over a range of KPA. The overall performance of the group of airports will be monitored against the shared performance targets. The performance of one single airport or the group of airports will be provided, suitably filtered to all the stakeholders (wide access to airport performance). When a group of airports (too small to have their own AOP) with similar operational needs have

decided to gather under a single AOP, there is a need to set and monitor the performance targets in order to further enable performance optimisation. Research may include TMA aspects e.g., planning (*R&I: airport automation including runway and surface movement assistance for more predictable ground operations*).

- **ATCO stress and fatigue risk assessment and ATCO resilience.** An increased level of ATCO productivity will make it possible to manage traffic growth with the current level of resources, thus improving cost efficiency. However, stress and fatigue are physiological responses that have negative effect on ATCO performance and hence on safety. ATCO resilience is the ability for controller individuals to detect, resist or recover from suffering negative experiences such as stress and fatigue. Research on solutions to predict and monitor these negative effects not only in actual environments, but also in future highly automated environments are crucial to identify corrective measures such as adaptive automation. Historical data may be exploited to find models to assess and predict stress or fatigue (system interactions, reaction times, ATCO tasks, voice frequency, communications, etc.). It is also known that individual particularities such as ATCO chronotype, hours of sleep, accumulative high workload in different shifts, may affect differently to stress or fatigue reporting. Research is needed on how individual features can affect stress and fatigue and how these can be incorporated in their assessment. In addition, ATCO resilience against stress and fatigue should be improved. Resilience has been proven to be associated with some inherent traits of individuals: is positively correlated with conscientiousness, agreeableness, openness to experience and extraversion, and negatively correlated with neuroticism. On the other hand, the formation and improvement of individual resilience are considered as the dynamic process, which could be learned at any period of life. Resilience could be acquired over a period by using a process rather than coming all at once. Psychological coherence training and biofeedback training have proven to be an efficient method for ensuring individual detection and recover from fatigue and stress; as well as for achieving resilience quickly during the short breaks in long-time continuing monitoring and working (*R&I need: Role of the Human*).

2.2.4.2.2 *Topic HORIZON-SESAR-2023-DES-ER2-WA2-2: ATM application-oriented research for air–ground integration and autonomy*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Capacity:** the integration of new airspace users and air vehicles (unmanned aircraft systems, HLO operations, etc.) shall not negatively impact capacity;
- **Cost-efficiency:** thanks to the new services supported by air–ground and air-air connectivity, cost-efficiency is expected to be improved;
- **Operational efficiency:** the proposed solutions are expected to contribute to the improvement of the operational efficiency thanks to advanced communication means and increased automation (e.g., machine-to-machine communication). In addition, further automation will improve trajectory management, in particular vertical flight efficiency;
- **Environment:** the proposed solutions shall aim at optimising fuel-burn and the CO_2 emissions per flight;

- **Safety:** increased air-ground autonomy will enable the human actors to be discharged from routine tasks and to focus on strategic tasks, including safety oversight of the operations;
- **Security:** The proposed solutions are expected to identify and mitigate the potential security risks deriving from the increased connectivity between stakeholders.

Scope

The challenge is to design and develop concrete innovative applications (that are already TRL1, achieved within SESAR programme or outside) that aim at increasing the level of air-ground integration, supported by high automation levels and that will enable the transition to trajectory based operations (TBO). The proposed solutions will aim at realising the Digital European Sky vision that foresees the full integration of an increasing number of new forms of mobility and air vehicles, which have a high degree of autonomy and use digital means of communication and navigation. The proposed solutions shall support the evolution towards the future ATM system, exploiting existing technologies as much as possible, and developing new ones in order to increase global ATM performance in terms of capacity, operational efficiency and accommodation of new and/or more autonomous air vehicles, i.e. supporting the evolving demand in terms of diversity, complexity from very low-level airspace to high-level operations. The challenge is to ensure the full integration of certified drones into all classes of airspace, full U-space services and single pilot operations thanks to increased automation and delegation of separation responsibility to systems.

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they have already successfully achieved TRL1 (within SESAR programme or outside) and include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the air–ground integration and autonomy flagship.

- **Frequency switching management.** This research will investigate, from a gate-to-gate perspective, the automation of air–ground coordination to ensure the use of automatic voice and datalink frequency selection for communications by the pilot and ATC. The scope of automatic frequency selection covers an assessment of multilink schemes, such as policy-based routing (including criteria for selection of terrestrial or satellite bearer and best frequency based on prevailing airspace and service requirements). This is expected also to support enhanced crew resource management, single-pilot and cross-border operations *(R&I need: enabling greater ground and airborne integration and wider performance)*.
- **Advanced air–ground integration for general aviation.** This activity will ensure that access to all airspace classes remains open to general aviation in an equitable manner and at an affordable cost as well as the leverage on-board technologies (potentially not certified) in order to guarantee better and safer flights for all general aviation users, including sports aviation. It may also include the development of a concept enabling VFR aircraft to share their intended plans in real time with ATC and/or U-space service providers through a low-cost non-certified EPP-like concept based on whatever application the general aviation pilot is using to plan his/her flight in real time. This solution would complement surveillance information and would result in a continually updated flight plan, which could be used to automatically change the destination airport, to ensure that general aviation pilots receive updated information if their plan

changes and to support search and rescue operations when no surveillance information is available. VFR pilots would retain at all times the same degree of flexibility in changing the plan as they have today. Research shall develop applications beyond the state of the art (e.g., existing apps for GA like Safesky) *(R&I need: enabling greater ground and airborne integration and wider performance)*.

- **Clear air turbulence data presentation to ATC.** According to IATA, turbulence is the leading cause of injuries to airline passengers and crews globally. Flight crews routinely report clear air turbulence to controllers, who, workload permitting, relay turbulence reports with aircraft that will be overflying the same area. However, controllers often are not able to properly relay this information. Turbulence information is also relevant for controllers, e.g., because it can support proactive management of level change requests. Research can propose potential solutions for sharing turbulence reports to controllers addressing how the information will be presented to ATCOs and how they would use it. Proposals should focus on improvement of the clear air turbulence prediction processes (*R&I need: enabling greater ground and airborne integration and wider performance*).
- **Evolution of controller/pilot communication.** In today's environment, each en-route or TMA sector requires a dedicated VHF frequency for controllers and pilots to communicate over, which means the lack of availability of VHF spectrum in areas with a high density of air traffic, can make it impossible to increase ATC capacity by adding additional sectors. However, the share of controller-pilot communications over datalink vs. those conducted over voice is expected to increase rapidly over the coming years. As voice communications become less and less frequent, it will be impractical to require a single VHF frequency to be reserved for the exclusive use of the controller-pilot communications within a sector. Instead, the SESAR long-term concept is that voice will be transmitted via the same channel as datalink, i.e. move to digital voice. The new concept also allows for an evolution of the voice communications concept. For example, in digital voice, the transmissions for change of frequency and checking into a sector would not be necessary anymore. Instead, the handover from one controller to the next will be linked to the handover of the CPDLC communications and be completely transparent to the flight crew, i.e. whenever the pilot makes a voice transmission, the communication would be routed to the controller in charge of the flight. Digital voice will also make it possible to configure voice communications as broadcast or point to point depending on the environment. Where broadcast is not in use, an access indicator might be implemented to indicate to the flight crew the voice channel is busy (without transmitting the content of the ongoing communication), to avoid simultaneous transmissions over the same channel. There is a need to further investigate how the dynamic allocation of IP connections may reduce the need for VHF channels on the ground side and the need for the airborne side to switch frequencies several times during the flight. In SESAR, the technical feasibility and performance of the digital voice concept has been researched by solution PJ.33-W3-02 in SESAR considering LDACS as the underlying technology. The objective of this element is to further develop the operational concept and make a holistic analysis of the potential for the concept to be supported by alternative datalink technologies, e.g., Satcom, commercial links, satellite-based VHF, etc. (*R&I need: enabling greater ground and airborne integration and wider performance*).
- **Air and ground synchronisation applications.** AI-powered systems are expected to be integrated into ground and cockpit systems, enhancing communication for trajectory

management and much more. The scope of this research includes the identification of innovative applications / AI-based solutions that could improve such synchronisation. Research aims at performing a risk assessment on loss of air-ground communications and determining continuity, integrity and performance requirements on air-ground communications for the proposed applications *(R&I need: enabling greater ground and airborne integration and wider performance)*.

- **Controller support systems for improved radio communication and inclusion of automation**. Several radio communications require the controller to bear a significant workload, be it for a negotiation process with pilots or repetition of routine messages, the coordination with datalink communication and the induced task of simultaneous input into a dedicated information system. The multiple remote tower use case is for example in need of a solution to address the specific problem of multiple frequencies management in a safe and easy way. Assistance, either automated or reducing time and workload for input or radio frequency management at large would therefore be beneficial. Research aims at developing a proof of concept for an enhanced system to assist radio management. This would relieve the controller from the active execution of input, ease message, identify potential errors and eventually enable automatic treatment of requests or communication (*R&I need: enabling greater ground and airborne integration and wider performance*).
- **Integration of super-high-altitude operating aerial vehicle.** These vehicles, which can be viewed as drones, will also need to be integrated, with entry and exit procedures through segregated or non- segregated airspace. As a result, new airspace users include highly autonomous vehicles. Safe separation management of this traffic and efficient integration into the traditional ATM operation is both a technical and operational challenge. By 2035, daily high-level operations (HLO) are expected and their transition from a segregated and/or non-segregated airspace have to be well established with appropriate regulations (with EASA involvement), clear technological capabilities and suitable performances for such air platforms. The research could also benefit from research on the physics of the atmosphere for such HLO, based on the existing state of the art. Research should consider the relevant human factor issues (*R&I need: super-high-altitude operating aerial vehicles*).
- **Single pilot operations (SPO).** Research aims at addressing the following aspects:
- Safety systems and crew health and HP monitoring systems for supporting SPO. In order to operate safely with a reduced crew, safety systems and crew health monitoring systems will be a key enabler to trigger the back-up modes in case of incapacitation, stress or exhaustion of crew members. This is of paramount importance in order to be able to recognise possible dangerous situations, forgotten steps of procedures or checklists, inappropriate or non-executed actions by the pilot.
- Incapacitation detection in SPO. Development of a highly reliable automated incapacitation detection system. Research addresses the challenges derived of a possible failure of the incapacitation detection system, false positives and how to address partial incapacitation or drift towards incapacitation. The transfer of authority can fall into a grey area between the air and ground pilots for a relevant period: crew resource management (CRM) procedures and guidelines for this new distributed crew should be developed and evaluated. The analysis of the transition period from nominal SPO case (on-board pilot in control) and incapacitation confirmation is as well under the scope.

- This research addresses also the expected role of FOC/WOC in the case of SPO abnormal situations: it requires their connection to ATC centres to support safe return to land even in a congested traffic environment. Research should consider the relevant human factor issues. Research shall consider the output of project SAFELAND (*R&I need: Single-pilot operations (SPO)*).
- **Machine-to-machine communication.** In addition to human-to-human communication, such as controller–pilot datalink communications (CPDLC), datalink will also support machine-to-machine communication. This covers for example a machine-to-machine negotiation-based conflict resolution. The development of mechanisms and tools for creating negotiation-based resolutions at conflict resolution and collision avoidance levels (e.g., what-if extended projected profile (EPP)-based tools, or ATC offering a choice to the FMS of two potential cruising levels) will be addressed. This is a flight deck to ATC solution (i.e. with airline operations centre involvement). Technical and operational requirements, as well as use cases and initial validation, will be addressed in this research *(R&I need: integrated 4D trajectory automation in support of TBOs)*.
- **FMS-twin for enhanced A/G connectivity.** The SESAR-developed availability of the flight management system (FMS) trajectory on the ATM ground systems via the EPP downlink has represented a breakthrough in ATM. This capability provides visibility to ATM systems of what is loaded in the FMS, thereby enabling a multitude of advanced applications on the ground. It is envisaged that additional applications can be developed if the ground ATM system also have availability of what-if FMS trajectories, which make it possible for ATM to anticipate how the trajectory would change under certain hypotheses. The hypothetical trajectory revision to be considered could be proposed by the ATM system, be proposed by the flight crew (potentially associated to a request for a clearance) or be automatically generated (to inform the ATM system of the way the FMS would implement different potential clearances that are relevant to the current context). However, development of additional applications for the FMS is slow and complex due to the safety criticality associated to the FMS flight-path control capabilities; for the same reason, once an FMS feature is developed, there is little flexibility for its evolution. A potential way through might be the development of an FMS-twin software, to be installed in an on-board embedded computer without flight-path control capabilities, in an Electronic Flight Bag without flight-path control capabilities, or in the FOC (on the ground). If located on board the aircraft, the FMS-twin should be able to exchange information with both ATM and the FOC through non-certified A/G links. The FMS-twin is expected to be a decision support tool enabling the A/G exchanges during the execution phase for both A/G FF-ICE/R2 negotiations for the update of the trajectory during the execution phase beyond the horizon of interest of ATC and A/G exchanges in support of the ATC TBO concepts. The research would explore the challenges of the FMS-twin concept, define a first set of candidate applications and perform an initial evaluation of potential benefits. Research shall take into consideration the potential applications to meet the needs of solution PJ.01-W2-08A2 and/or solution PJ.07-W2-38 *(R&I need: Integrated 4D trajectory automation in support of trajectory-based operations (TBO)).*
- **Advanced aircraft on-board systems.** Research aims at developing potential ATM applications such as: tools for monitoring flight crew workload, support to 4D navigation (applied to all types of flight from low altitude to sub-orbital), increased situational awareness, self-separation of traffic, traffic prediction, collision alerting and avoidance, all weather approach and landing, and automatic flight control . Research also addresses

pilot support systems for automatic route negotiation with ATCOs. A route change request requires the pilot to sustain a negotiation process with ATCOs over a shared radio channel while performing its duty. Industry is developing tools for supporting the pilot during this process that, however, are very limited in terms of automation and, as a result, require still active execution of the task by the pilot. Research aims at developing a proof of concept of an automatic system for reliving the pilot from the active negotiation by delegating that to an automated system (*R&I need: integrated 4D trajectory automation in support of TBOs*).

2.2.4.2.3 Topic HORIZON-SESAR-2023-DES-ER2-WA2-3: ATM application-oriented research for the aviation Green Deal

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions are expected to contribute to the achievement of the objectives of a 55 % reduction in greenhouse gas emissions by 2030 and net-zero greenhouse gas emissions by 2050, by maturing concepts enabling optimal and optimum green trajectories, thus reducing CO_2 and non CO_2 emissions, as well as contributing to new and up-to-date models to tackle emissions and noise and improve local air quality.
- **Capacity:** the proposed solutions are expected to improve airspace capacity through the identification of optimal and environmentally friendly flight trajectories, taking also into consideration the new entrants (e.g., U-space flights).
- **Cost-efficiency**: saving fuel for airspace users will reduce CO_2 emissions and related costs for emission allowances.

Scope

The challenge is to design and develop concrete innovative applications (that are already TRL1, achieved within SESAR programme or outside) that aim at achieving the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement. The proposed solutions shall demonstrate their potential to accelerate the shift to smarter and more sustainable mobility, to improve the fuel efficiency and reduce the emissions (both CO_2 and non-CO2) generated by ATM operations and increase the understanding of the climate impacts of aviation to better anticipate them and take adaptation measures. The challenge includes the adaptation of the route charging scheme to take into consideration the green deal objectives and how to enable the definition of globally harmonised policies and regulations to support climate-friendly flight operations. The challenge includes as well the development of innovative ideas to accelerate decarbonisation of ATM through the integration of energy, transport and digitalisation platforms that are at the base of the green transition.

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they have already successfully achieved TRL1 (within SESAR programme or outside) and include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the aviation green deal flagship.

- **Multi-scale multi-pollutant air quality systems**. Development of solutions for the evaluation of the impact that the air traffic regulation policy options can have on the environment and climate. The proposed solutions should be able to follow the fate of aircraft emissions in the atmosphere on both the global/regional scale (e.g., transport of pollutants from the troposphere to the stratosphere, impact onto the radiative properties of the atmosphere, ozone production, etc.), and on the local scale (e.g., impact close to an airport area during landing and take-off phases). The main area of applicability of such a solution is to support the aviation community in estimating the extent of the environmental impacts that current and future air traffic movements might have. Research shall address integration and optimization aspects to reduce the overall computational time and human errors (*R&I need: optimum green trajectories*). Research shall take into account the output of project CREATE.

- **Greener long-haul flights**. Long-haul flights contribute the most to aviation CO_2 emissions and other environmental impacts. Europe has a big contribution to this market sector and therefore it is essential to explore innovative coordination and interoperability actions with ATM systems of destination/origin regions of European long-haul flights in order to reduce the overall environmental impact of these operations. Research aims at developing applications that will contribute to the green improvement of long haul flight operations e.g., increasing the level of ATM automation, air-ground collaboration *(R&I need: optimum green trajectories).*
- **Validation of novel metrics in support of environmental impact assessment in ATM.** The collaborative management of environmental impacts and the implementation of strategies to reduce them require the development of indicators/metrics that will enable, on one hand, all ATM decision-makers to make informed decisions at different levels and, on the other hand, to communicate on ATM community efforts towards environmental sustainability. Research aims at developing and validating new environmental metrics for use in R&I and/or operations. The areas for development include use of EPP data for environmental performance assessment, development of meaningful operational proxies that can support ATM decision making in ATFM or ATC operations, development of methodologies for providing an accurate estimation of CO_2 and non-CO_2 emissions and noise with minimal input data (e.g., based only on surveillance data combined with flight plan data), etc. The research can also investigate the adaptation to ATM of software and methodologies currently in use by airlines to optimise their environmental performance (*R&I need: accelerating decarbonisation through operational and business incentivisation*).
- **Explore the concept of “green flag” flights.** Making operations greener needs a real boost based on realisable operational frameworks and incentives for the ATM actors. These incentives encompass all phases of flight and start from strategic and pre-tactical phases, where ATM decision-makers have to make informed decisions towards higher environmental sustainability. In ATM process terms, this means an environmentally responsible ATFCM, an E-ATFCM. An enabler of this E-ATFCM framework is to explore new environmental indicators oriented to facilitate decisions to ATM actors. The concept of “green flag” seeks the establishment of a methodology for environmental scoring of flight plans, analysing all aspects derived from the plans that may have an impact on environment. This includes all type of emissions, contrails and noise. The concept may also include the consideration of whether there is availability of alternative means of transport for the same route, e.g., train, so that requirements for a flight to be “green flagged” are higher where there are viable alternatives. The low impact “green flagged” flight plans may benefit from having priority in slot allocation, lower route charges and other advantages linked to pre-tactical and tactical operational decisions.

The concept of "green flight" needs to be grounded in a careful review of environmental impact aspects and the validation of the proposed scoring against reference measurements of impact. The research must also address the impact of the concept in the SES performance scheme, including the consideration of trade-offs with other key performance areas (*R&I: Accelerating decarbonisation through operational and business incentivisation*).

- **Automated stepless aircraft high-lift device management.** The research activities shall aim at supporting the development of a concept for the stepless management of aircraft high-lift devices with automated support. The objective is to support pilots in managing the energy of the aircraft during the last (e.g., 10,000 ft.) part of the descent phase, in order to reduce fuel consumption and noise perception on the ground. The improved high-lift device management shall improve the adaptability of the flight to the prevailing approach conditions in terms of current aircraft mass and weather conditions. The ability of the aircraft to apply speed changes as required by ATC or potentially by an on-board airborne separation assistance system (ASAS) such as interval management will also be improved, and the environmental impact of such speed changes will be reduced. The research shall take into account both classic 3-degree approach paths and increased glide-slope paths. Research shall take into consideration the results of project DYNCAT (*R&I need: environmentally optimised climb and descent operations (OCO and ODO)*).
- **Green applications to reduce ATM impact on non-CO_2 emissions, noise and air quality.** Research aims at developing innovative applications that could contribute to reduce the impact of ATM on non-CO_2 emissions, noise and air quality pollutants. The air quality pollutants (nitrogen oxides (NO_X), particulate matter (PM), volatile organic compounds (VOCs), sulphur dioxide (SO_2), carbon monoxide (CO) and unburnt hydrocarbons (HC)) not only concern the airport local area: their potential impact may affect a substantial area around the airport and other ATM stakeholders could collaboratively work with the airport to design, implement and operate solutions to minimise these aviation impacts. For non-CO_2 emissions, these green applications could consist of different ATC support tools (automated advice to adapt pre-tactical and tactical flight planning to reduce non-CO_2 emissions, monitoring tools on environmental impact, improved capabilities to ensure that traffic minimize non-CO_2 emissions in different phases of flight, etc.). The proposed solutions may use AI for optimising trajectories, creating 'green' routes and increasing prediction accuracy. Research could also consider applications for greener network operations e.g., DCB with a lower monitor value per sector to ensure not only safety but also to enable optimal environmental efficiency to be facilitated for each flight (*R&I need: non-CO_2 impacts of aviation).*

2.2.4.2.4 Topic HORIZON-SESAR-2023-DES-ER2-WA2-4: ATM application-oriented research for Artificial Intelligence (AI) for aviation

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment:** the proposed solutions are expected to demonstrate the positive impact of AI-based solutions on operational mitigation of aviation's environmental impact.
- **Capacity:** the proposed solutions are expected to contribute to capacity by addressing AI-based human operator support tools to, for example, ensure the integration of new entrant aircraft types.

- **Operational efficiency:** the proposed solutions are expected to improve the operational efficiency by enabling better traffic predictions and forecasts, thus contributing to punctuality.
- **Safety:** the proposed solutions are expected to maintain at least the same level of safety as the current ATM system.
- **Security:** the proposed solutions are expected to maintain at least the same level of security as the current ATM system.

Scope

The challenge is to design and develop concrete innovative AI applications (that are already TRL1, achieved within SESAR programme or outside) that aim at:

- Enabling better use of data, leading to more accurate predictions and more sophisticated tools (e.g. new conflict detection, traffic advisory and resolution tools), increased productivity and enhancing the use of airspace and airport;
- Enriching aviation datasets with new types of datasets unlocking air/ground AI-based applications, fostering data-sharing and building up an inclusive AI aviation/ATM partnership to better support decision-makers, pilots, air traffic controllers and other stakeholders;
- Supporting (i.e. AI assistants) all ATM actors from planning to operations and across all airspace users;
- Enabling the virtualisation of infrastructure and air traffic service provision in all types of airspace, ranging from very low to high altitude operations. In doing so, AI will enable the system to become more modular and agile, while building resilience to disruption, traffic growth and greater airspace user diversity;
- Developing new ATM/U-space services.

The SESAR 3 JU has identified the following innovative research elements that could be used to achieve the expected outcomes. The list is not intended to be prescriptive; proposals for work on areas other than those listed below are welcome, provided they have already successfully achieved TRL1 (within SESAR programme or outside) and include adequate background and justification to ensure clear traceability with the R&I needs set out in the SRIA for the AI for aviation flagship.

- **Innovative methodologies for quantifying the impact on safety and resilient performance of higher automation in ATM.** This research aims at developing new methodologies for quantifying the impact on safety and resilient performance of higher automation in the ATM system applying data-driven techniques. These methodologies shall provide additional tools for the ATM stakeholders for evaluating and quantifying the impact of higher automation (e.g. AI/ML-based SESAR solutions) and could be potentially used for in-depth verification of safety criteria associated to a given SESAR solution in early R&I stages, but also to evaluate the state of the current system. Research shall built on the work performed by project FARO on en-route environment and automation levels 2/3, but it shall extend to other operating environments and to higher automation levels (4/5) *(R&I need: trustworthy AI powered ATM environment).*
- **Safety filter for AI solution.** Study safety filter concept for data prediction responsible for deciding on the usability of the ML model predicted data. Safety filter works as a safeguard, without human intervention, and qualifies the predicted sensor-data, as valid or invalid, by applying captured expertise rules. Research may address the application

of dynamic risk assessment (DRA) and business impact assessment (BIA) techniques to distribute and enrich the exchange of information with federated learning architectures (*R&I need: cyber-resilience*). Research shall take into account the output of project SINAPSE.

- **Artificial situational awareness:** This research aims at developing artificial situational awareness solutions based on high-integrity information that are able to describe the traffic situation on a sector (en-route / TMA) or airport and, integrated with machine-learning (ML), enable the assessment of probabilistic events (e.g., trajectory prediction or conflict detection). By combining reasoning engine with machine learning, the proposed solutions shall be able to assess complex interactions between objects, draw conclusions, explain the reasoning behind those conclusions, and predict future system states. The objective is to develop AI-based systems that can assist ATCOs with monitoring tasks and contribute to the team situation awareness (SA): a situationally aware system would share the ATCOs' SA since it would have access to the same data as an ATCO. Research may:
  - Assess how ML module predictions could use the optimization of their anticipation spans as they differ from ATCOs;
  - Analyse how automation and adaptation to novel system changes ATCOs' learning success;
  - Investigate whether certain information could pertain to shift supervisors, Network Managers, ATSEP and FMPs;
  - Explore the possibility of flexible machine/machine coordination between sectors or units;
  - Develop an HMI that will allow the ATCOs to review information, inform ATCOs with the right timing, be able to recognise when certain information is necessary in order to avoid ATCOs attention dissipating on less important information and additional memory load, recognise when an ATCO SA is degraded and provide the necessary alerts at an appropriate time, etc.;
  - Develop scenario simulators so that, through probabilistic models, future scenarios can be predicted;
  - Validate benefits in terms of safety (e.g., by introducing an additional safety net performing tedious monitoring tasks with high reliability), interoperability between different systems (e.g., by enhancing data handling) and capacity (e.g., by automating some of the monitoring tasks and enabling the introduction of other automation systems).

Research shall take into account the output of project AISA *(R&I need: human–AI collaboration: digital assistants*).

- **Explainable Artificial Intelligence (XAI)**: since the decisions provided by AI/ML algorithms are often opaque, non-intuitive and not understandable by human operators, this represents a limitation to their applicability in ATM. The objective of this research is to improve transparency of automated systems in the ATM domain investigating methods based on Explainable Artificial Intelligence (XAI) in operational use cases e.g., predicting air traffic conflict resolution and delay propagation, validating the robustness and transparency of the system, etc. Research shall take into account the output of project ARTIMATION *(R&I need: human–AI collaboration: digital assistants)*.

- **AI-powered co-piloting.** Research aims at investigating how AI can support pilots in complex and critical situations, when workload may be high and/or the time to react very limited. For these situations, research should focus, for example, on how to exploit high levels of automation to perform non-critical tasks for pilots and how the HMI should work during such operations, so the pilot can focus on essential tasks e.g., during taxi-out, descend, approach and landing. These applications may play a significant role in the transition to single pilot operations. In addition, AI-powered applications could support the pilot in situations where workload is low e.g., engaging pilot's attention and alert the pilot in case something unexpected happens. Research may address the development of algorithms based on reinforcement learning to help the pilot make decisions. The research results should demonstrate how the technology could support pilots in carrying out their tasks (e.g., demonstrate an increase in human capabilities during the execution of complex scenarios or a reduction in human workload in the execution of standard tasks), and assess the impact on the role of the human *(R&I need: human–AI collaboration: digital assistants)*.
- **AI for complex operations.** This research is about developing AI-based human operator support tools to ensure the safe integration of new entrant aircraft types into an increasingly busy, heterogeneous and complex traffic mix (i.e. unmanned aircraft systems, supersonic aircraft, hybrid and fully electric aircraft). Algorithms for decision-making based on neural networks and classical optimization techniques could be addressed. Research may also consider the use of more advanced techniques such as reinforcement learning. Research should also cover the wider implications for other organisations and the impact on the network *(R&I need: human–AI collaboration: digital assistants)*.
- **User interface providing conflict resolution advisory transparency**. This research focuses on visual elements that allow better understanding why a particular conflict resolution solution is recommended. The visual elements increase the transparency of advisories by providing the operator an insight into the deeper structure of the work domain as well as the inner workings of the AI agent. Research may address:
  - The potential benefits of advisory transparency on advisory acceptance and system trust in relation to ecological approaches, AI interpretability models, and the connection between the two. Previous research on this field suggests that transparency alone may not be suitable as a measure for increasing operators' acceptance of advisories and trust in a system when that system performs different from the individual;
  - Transparency mechanisms for supporting the ATCOs in understand how the system works (e.g., the data processing, filtering, constraints etc. in the model), how it derived a specific advisory (relationships between input data and output), and why the proposed advisory is considered best (e.g., best match to the individual, group, or optimized according to reinforcement learning (RL) model).

Research shall take into account the output of project MAHALO (*R&I need: human–AI collaboration: digital assistants*).

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- **Guidelines for the design of future AI systems**. This research relates to the application of EASA guidelines to the development of AI enabled systems in ATM. Research shall also contribute to the update of EASA guidelines, including feedback on the effects of conformance, transparency and complexity and other challenges associated to the design of future AI systems (e.g., trade-offs between privacy and transparency). Research may consider human-in-the-loop simulations considering controller trust, acceptance, workload and human/machine performance but also new approaches for validation, verification, and testing of AI applications, specifically for safety critical applications e.g., developing an agile validation methodology data centric security capabilities for AI systems to promote reliability, increase trust, and maintain a competitive edge in today's rapidly evolving technological landscape. Close coordination with EASA is expected, to ensure complementarity and consistency with EASA activities on the following areas:
  - Trustworthiness: capability to keep input and output privacy with relatively high cyber-security protection. Support the definition of the requirements and needs for input/output verification (related to trustworthiness in the framework of Structured Transparency) in the ATM context in support of the EASA certification process descriptions. Validate and further develop requirements and potential solutions with a co-joint analysis together with EASA and other operational experts. Clarify some of the challenges faced by EASA, e.g., to define the system requirements, processes, and tools that are needed to perform the validation and certification process.
  - Learning Assurance: including the consideration of realistic operational cases in realistic operational conditions and new ML techniques. Need to develop specific assurance methodologies to deal with learning processes;
  - AI explainability, which goes beyond the ML techniques to extract information from the models, and includes the interactions with other systems and with the human operators (human factors). Research may help to clarify which requirements and processes the target AI/ML system should comply with in order to be certifiable for operations;
  - AI Safety case: discussing with EASA and other safety experts about the needs and requirements of a concrete safety-case can help to clarify and support the development the EASA guidelines for certification.

The concept of safety critical levels need to be further developed for AI applications in ATM. Research covers the definition and analysis of safety-related use cases for different safety level assurances. These safety levels may imply either the adaptation of current SW verification methods or the development of new ones to guarantee the safe of operation of AI in ATM. Research shall take into account the output of projects MAHALO, AICHAIN (*R&I need: human–AI collaboration: digital assistants*).

- **Support to the certification of novel ATM-related AI/ML-based airborne and ground systems that enable higher levels of automation.** The objective of this research element is to address issues related to the certification of novel ATM-related airborne and ground systems that enable higher levels of automation. Research will address solutions, methods, etc. that could support and simplify the certification process of innovative systems based on machine learning or artificial intelligence techniques. It is expected that proposals define a holistic approach to address this challenge considering not only technical aspects of the certification but also legal and regulatory aspects including privacy. Research may explore and assess potential approaches that could be applied for the certification of automation and that allow to demonstrate the safety of automation during nominal and non-nominal conditions. Of particular interest is to show how safety can be ensured even if not all situations and variations of parameters can be anticipated during the design phase. Proposals may apply uncertainty quantification to address this issue. Research may also address the specific challenges of certification of automation that can adapt its behaviour to changes of the environment over time. Research activities shall take into account other initiatives developing safety of life systems that may have different approaches to certification and review their applicability to ATM (e.g., EGNOS) (*R&I need: human–AI collaboration: digital assistants*).

- **Development of framework to achieve effective Human-AI Teaming.** As AI is developed to provide more intelligent behaviours, it is argued that there will be an increased need for AI systems to function effectively as team members with humans. Just as human-only teams have many advantages over solo workers (e.g., to manage workload fluctuations, provision of a diverse set of skills and capabilities toward the completion of common goals), human-AI teams can have similar benefits over human-only teams. When considering an AI system as a part of a team, rather than simply a tool capable of limited actions, the need for a framework for improving the design of AI systems to enhance the overall success of human-AI teams becomes apparent. A failure to consider the needs of the many air traffic controllers, pilots, flight dispatchers, flow managers, etc. who are responsible for successful ATM operations will result in AI technologies that eventually fail to provide the necessary high levels of performance and may instead cause inefficiencies and safety problems. The design of AI systems for human-AI teams needs to incorporate several highly interrelated considerations. These include designing the AI system to support not only task work, but also teamwork. These interrelated considerations include considerations about human-AI team performance and processes, team trust, team biases, team situational awareness, team training needs, human-AI interaction methods, interface, transparency and explainability and Human-System Integration processes, measures, and testing (*R&I need: human–AI collaboration: digital assistants*).
- **Extended reality (XR) in support of ATM operations.** The term eXtended Reality (XR) is includes technologies that enhance or replace our view of the world: encompasses augmented reality (AR), virtual reality (VR), and mixed reality (MR). Virtual reality guides the observer out of his/her actual environment and into an artificial one. Research aims at using virtual reality to improve the efficiency of ATM operations. Augmented reality enhances certain objects through transparent lenses in the observers' field of vision. MR sits somewhere between AR and VR, as it merges the real and virtual worlds. An evident area of interest is training be it training of maintenance personnel or ATCO/pilot training. ATCO virtual training goes beyond the execution of remote simulations or validations as the ATCO would be physically located anywhere since the simulator HMI is created with extended reality equipment such as glasses and/or haptic devices. The research would investigate the operational and technical feasibility of training individually or collectively with other ATCOs as if they were executing remote simulations or validations through connection with remote real simulators. Research includes how ATCO performance data could be collected in real time to monitor training progress. Artificial intelligence could support the monitoring and detect when the ATCO has acquired the corresponding competence, or the ATCO needs to emphasize training

in particular aspects. Pseudo piloting as well as the representation of adjacent sectors could be also based on speech recognition making the pilots and adjacent controllers also virtual. However, the scope under research is not only limited to training, but could also address specific operational challenges in different environments e.g., airport, TMA, en-route supported by XR techniques:

- Collaborative environment with multiple users that have the ability to interact with the rest;
- Applications to access to all relevant information in real time for efficiently and safely managing operations;
- Digital assistants to support decision-making, etc.);
- Location of tactical elements of operation in the field of vision obtained through advanced communication protocols: pilots, ATCO, maintenance, etc.;
- Display of indications, messages, status of own elements, alerts or information of interest;
- Intelligent adaptation of the displayed content according to the operating environment;
- Gestural or voice interaction (synthesizer and voice command);
- Situational awareness of the state of operations through AI.

The proposal shall show a thorough knowledge of past SESAR activities on this field i.e. ER RETINA and solution PJ.05-W2-97.1 (*R&I need: human–AI collaboration: digital assistants*).

- **AI based human-machine collaboration to anticipate and respond to human needs by understanding ATCO's intent and goals**. Research aims at developing potential AI based solutions able to understand the traffic situation and, in combination with ATCO attention tracking technologies, to infer ATCO's intent. The proposed solutions will support the ATCO not only by performing tasks he/she already intends to perform, but also by autonomously performing a task that is outside of the current scope of ATCO's attention. ATCOs could then set the desired level of supporting actions performed by the AI team member (adaptive automation) and still maintain situational awareness by performing their usual tasks. Research may evaluate the potential use of graph-based models and joint neural networks to help the ATCO better understanding the traffic situation. Research shall address the impact on the role of the human (*R&I need: human–AI collaboration: digital assistants*).
- **Integrated platforms for the nowcasting and forecasting of multiple meteorological hazards.** This research aims at developing of integrated platforms to incorporate predictions of atmospheric hazards (e.g., SO_2 contaminants, severe weather situations such as deep convection and extreme weather and climate hotspots potentially contributing to global warming, etc.). The focus is to enhance the situational awareness of all stakeholders in case of multiple hazard crisis by facilitating the transfer of required relevant information to end-users, presenting such information in a user-friendly manner to ATM stakeholders, ultimately anticipating severe hazards and fostering better decision-making. Research may address:
  - Extension of nowcasting models of SO_2 in 1D (values for a given location) to 2D (lat-long) and 3D and nowcasting products for dust, ash, volcanic aerosol and precursors and smoke;

- The consideration of additional observations (e.g., radar, satellite, sensors on board the aircraft) to better characterize the weather extremes and enhance the quality of the extreme weather nowcasting;
- The integration of space weather and climate change in the new MET services;
- The application of artificial intelligence or deep learning models based on recurrent networks could be used to better predict weather phenomena;
- Address potential air traffic controller decision support systems able to import and process the meteorological forecasts and to adapt tactical arrival and departure scheduling to changing extreme weather conditions;
- Target airport, TMA and en-route operating environments and the potential use by different stakeholders (e.g., Network Manager, ANSPs (flow management positions and air traffic controllers), airports, airlines (dispatchers and pilots), etc.);
- Address the assessment of potential benefits in terms of capacity, efficiency, safety, predictability and resilience.

Research shall take into account the output of project ALARM *(R&I need: AI Improved datasets for better airborne operations)*.

- **Standardised testbed platform for developing, testing, and benchmarking AI-applications in ATM**. Research in artificial intelligence in ATM has been traditionally fragmented in the area due to the lack of standardised testbeds. The development of a testbed to be adopted as a common framework for future research in applied AI in ATM will enable reproducibility and considering open science practices. Research covers the definition and publication of a library of use cases, including input and output data associated to persistent identifiers (such as digital object identifier (DOI)). This will ensure findability and a wider adoption within the ATM research community (*R&I need: AI Improved datasets for better airborne operations*).

2.3 Call HORIZON-SESAR-2022-DES-IR-01

2.3.1 Scope of the call

The HORIZON-SESAR-2022-DES-IR-01 call for proposals is composed of 6 work areas.

- **WA1** covers transversal activities, with a focus on master planning and performance management.
- **WA2** comprises the industrial research required to achieve the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, which means accelerating the shift to smarter and more sustainable mobility. This implies a need for aviation to intensify its efforts to reduce emissions, in line with the targets set in *Flightpath 2050*.
- **WA3** will focus on the delivery of the next generation of enabling platforms and services with a view to achieving the ambition of the Digital European Sky and phase D of the European ATM Master Plan.
- **WA4** covers fast-track innovation and uptake activities addressing U-space and UAM.
- **WA5** covers fast-track innovation and uptake activities addressing capacity on demand and dynamic airspace, virtualisation and cybersecure data-sharing, multimodality and passenger experience, and the aviation green deal.
- **WA6** comprises the industrial research activities required to achieve TRL6 for the key R&D solutions that make up the European ATM Master Plan 2020 phase C ambition, establishing a solid foundation for European ATM Master Plan phase D. The scope of this work area includes a number of elements that, although addressed in SESAR 2020 wave 1 and wave 2 activities, did not finally reach TRL6. It also covers the integration of solutions that, having achieved (or nearly achieved) TRL6 as part of previous SESAR programmes, still require integrated validation activities to facilitate and de-risk the industrialisation and deployment phases: these activities may target a TRL7 level of maturity. The work area may also include activities for the early integration of less mature SESAR Solutions.

2.3.2 EUROCONTROL services

As stated in the Single Basic Act in recital 93, the EUROCONTROL organisation possesses a unique and appropriate infrastructure, together with the necessary administrative, IT, communications and logistics support services that could be beneficial to the implementation of the SESAR 3 Programme.

Applicants could benefit from the following EUROCONTROL expertise and services:

- ATM operational expertise
- civil–military integration expertise
- network operational data
- network management validation infrastructure
- reference tools for the assessment of network performance and environmental impact.

Should the provision of those EUROCONTROL services be required, applicants are invited to coordinate with EUROCONTROL to include the services in their proposals.

2.3.3 General conditions for the call

Unless otherwise stated, this call follows the general conditions laid down in the General Annexes to the Horizon Europe work programme for 2021–2022, adopted by the European Commission ([43]).

Topic	Type of actions	Budget (million EUR) for 2022	Maximum expected EU contribution per project (million EUR) ([44])
Opening: 7 April 2022 Deadline ([45]): 13 October 2022			
HORIZON-SESAR-2022-DES-IR1-WA1-1	Coordination and support action (CSA)	4.00	2.00
HORIZON-SESAR-2022-DES-IR1-WA1-2			2.00
HORIZON-SESAR-2022-DES-IR1-WA2-1	Research and Innovation action (RIA)	30.00	5.00
HORIZON-SESAR-2022-DES-IR1-WA3-1	Research and Innovation action (RIA)	55.00	12.00
HORIZON-SESAR-2022-DES-IR1-WA3-2			12.00
HORIZON-SESAR-2022-DES-IR1-WA3-3			12.00
HORIZON-SESAR-2022-DES-IR1-WA3-4			12.00
HORIZON-SESAR-2022-DES-IR1-WA3-5			12.00
HORIZON-SESAR-2022-DES-IR1-WA4-1	Innovation action (IA)	35.00	7.00
HORIZON-SESAR-2022-DES-IR1-WA5-1	Innovation action (IA)	22.00	5.00
HORIZON-SESAR-2022-DES-IR1-WA5-2			5.00
HORIZON-SESAR-2022-DES-IR1-WA5-3			5.00
HORIZON-SESAR-2022-DES-IR1-WA5-4			5.00
HORIZON-SESAR-2022-DES-IR1-WA6-1		25.00	5.00
HORIZON-SESAR-2022-DES-IR1-WA6-2			5.00

([43]) European Commission Decision C(2021)1940 of 31 March 2021.
([44]) Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
([45]) The executive director responsible may delay the deadline(s) by up to 2 months. All deadlines are at 17.00.00 Brussels local time.

HORIZON-SESAR-2022-DES-IR1-WA6-3	Research and Innovation Action (RIA)	5.00
HORIZON-SESAR-2022-DES-IR1-WA6-4		5.00
Overall indicative budget	**171.00**[46]	

Table 55: Budget allocation and maximum expected EU contribution per project per Work Area under the HORIZON-SESAR-2022-DES-IR-01 call for proposals

Type of conditions	**Information on the conditions**
Admissibility conditions	The conditions are described in General Annex A to the Horizon Europe work programme for 2021–2022.
Eligibility conditions	The conditions are described in General Annex B to the Horizon Europe work programme for 2021–2022.
Financial and operational capacity and exclusion	The criteria are described in General Annex C to the Horizon Europe work programme for 2021–2022.
Award criteria	The criteria are described in subsection 2.2.4 below. Moreover the following weighting will apply: • excellence: 40 % • impact: 40 % • implementation: 20 %
Documents	The documents are described in General Annex E to the Horizon Europe work programme for 2021–2022.
Procedure	The procedure is described in General Annex F to the Horizon Europe work programme for 2021–2022. The following exceptions apply: • to ensure a balanced portfolio, grants will be awarded to applications not only in order of ranking but at least also to those that are the highest ranked within topics within the same work area, provided that the application attains the threshold; • the evaluation committee may be composed partially of representatives of EU institutions and agencies (internal experts).
Legal and financial set-up of the grant agreements	The rules are described in General Annex G to the Horizon Europe work programme for 2021–2022. The following exceptions apply. 1) A funding rate of 70 % applies to all beneficiaries (regardless of their legal status). 2) Beneficiaries will be subject to the following additional dissemination obligations: ○ beneficiaries must make proactive efforts to share, on a royalty-free basis, in a timely manner and as appropriate, all

([46]) The new overall indicative budget is million EUR 182.77.

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	relevant results with the other grants awarded under the same call; ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement. 3) Beneficiaries will be subject to the following additional exploitation obligations: For the purpose of complying with the objectives set in Council Regulation (EU) 2021/2085, the SRIA and the European ATM Master Plan, ○ beneficiaries must make available for reuse under fair, reasonable and non-discriminatory conditions all relevant results generated, through a well-defined mechanism using a trusted repository; ○ if the purpose of the specific identified measures to exploit the results of the action is related to standardisation, beneficiaries must grant a non-exclusive licence to the results royalty-free; ○ if working on linked actions, beneficiaries must ensure mutual access to the background to and to the results of ongoing and closed linked actions, should this be necessary to implement tasks under the linked actions or to exploit results generated by the linked actions as defined in the conditions laid down in this biannual work programme and in the call for proposals. ○ beneficiaries must acknowledge these obligations and incorporate them into the proposal, outlining the efforts they will make to meet them, and into Annex I to the grant agreement. 4) Grants awarded under this topic will be linked to the following actions: ○ Call HORIZON-SESAR-2022-DES-IR-01 ○ Call H2020-SESAR-2020-2 ○ Call H2020-SESAR-2019-1. A collaboration agreement is required.
Other conditions	The integration of a gender dimension (sex and gender analysis) into R&I content is not a mandatory requirement.

Table 56: General conditions for the HORIZON-SESAR-2022-DES-IR-01 call for proposals

2.3.4 Award criteria

Transversal activities (WA1)

Type of actions	Excellence *(The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)*	Impact	Implementation

Coordination and support actions (CSA)	1. Clarity and pertinence of the project's objectives: degree to which the objectives and scope are compliant with the call material, well understood and fully addressed. 2. Quality of the proposed coordination and/or support measures, including soundness of the methodology: degree to which the proposed methodology is feasible and appropriate to address the required coordination and support actions.	1. Credibility of the pathways to achieve the expected outcomes and impacts specified in the call material and of the ATM research. 2. Suitability and quality of the measures in terms of maximising expected outcomes and impacts, as set out in the D&E plan, including communication activities.	1 Quality and effectiveness of the work plan and assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. 2. Capacity and role of each participant and the extent to which the consortium as a whole brings together the necessary expertise.

Industrial research and validation activities (WAs 2, 3 and 6) and fast-track innovation and uptake (WAs 4 and 5)

Type of actions	**Excellence** *(The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)*	Impact	Implementation
Research and innovation actions (RIA) Innovation actions (IA)	1. Clarity and pertinence of the project's objectives: degree to which the objectives and scope are compliant with the call material, well understood and fully addressed 2. Soundness of the proposed methodology for developing the SESAR solutions from their initial to their target maturity level, including the underlying concepts, models, assumptions and interdisciplinary approaches. This criterion also includes appropriate consideration of the integration of a gender dimension into R&I content and the quality of open	1. Credibility of the pathways to achieve the expected outcomes and impacts specified in the call material. 2. Appropriateness of the contribution to standardisation and regulation: the extent to which the proposal demonstrates that the project will contribute appropriately to the relevant standardisation and regulatory activities. 3. Suitability and quality of the measures in terms of maximising expected outcomes and impacts, as set out in the D&E plan, including communication activities.	1. Quality and effectiveness of the work plan and assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall 2. Capacity and role of each participant and the extent to which the consortium as a whole brings together the necessary expertise.

	science practices ([47]), including sharing and management of research outputs and engagement of citizens, civil society and end users where appropriate. 3. Level of awareness of the state of the art: degree to which the proposal demonstrates knowledge of current operations and relevant previous R&D work (both within and outside SESAR), explains how the proposed work will go beyond the state of the art and demonstrates breakthrough innovation potential.		

2.3.5 Specific conditions and description of topics for each work area

2.3.5.1 *Work Area 1: Transversal activities*

Specific conditions for WA1	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 2.00 million would allow the outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 4.00 million
Type of actions	Coordination and support action (CSA)
Other requirements	The maximum project duration is 36 months.

2.3.5.1.1 Topic HORIZON-SESAR-2022-DES-IR1-WA1-1: Performance management and network impact assessment

Expected outcomes

Although the responsibility for conducting individual performance assessments and CBAs lies with the SESAR 3 projects, there is a need for the SESAR 3 JU to engage in a continuous process of performance evaluation to ensure that it is moving towards the performance ambitions specified in the European ATM Master Plan. This includes being able to assess and provide a consolidated view of the performance impact of future ATM concepts and solutions at ECAC network level, bringing together a

([47]) See the EU's open science policy (https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en).

bottom-up view of performance of the matured solutions with a top-down view of network performance.

Scope

The SESAR performance management process steers the overall R&I work, with reference to the SESAR performance ambitions specified in the European ATM Master Plan. It is based on the application of the SESAR performance framework. The SESAR performance management process reconciles and maps the performance assessments and results delivered by the R&I projects with the SESAR performance ambitions. It also ensures aggregating these results through the simulation of the relevant SESAR Solutions with the dual objective of delivering an ECAC-wide performance view and supporting for deployment, the development of the Master Plan level 3 implementation objectives based on these aggregated performance simulation results.

To achieve the expected outcomes, the activities to be performed under the leadership of the SESAR 3 JU will focus on the following areas.

- Performance framework:
  - maintain reference methods and performance framework (upon the explicit request of the SESAR 3 JU);
  - if required, train and coach R&I project staff to ensure the correct application of the performance methodologies;
  - at the request of the SESAR 3 JU, contribute to solutions maturity gates to confirm that a robust performance approach based on the methodology has been applied by the projects.
- Performance assessment and network impact assessment:
  - capture and aggregate the performance assessments delivered (for completed R&I) and planned to be delivered (for R&I in progress) by R&I projects;
  - run integrated simulation on multiple SESAR Solutions, duly replicating observed real-world operational environments to assess the impact that they could have at network level;
  - maintain a dashboard showing actual versus planned network performance impact enabled by SESAR 3 JU work programme delivery.

2.3.5.1.2 Topic HORIZON-SESAR-2022-DES-IR1-WA1-2: Master planning and monitoring

Expected outcomes

The SESAR 3 JU is responsible for the execution and maintenance of the European ATM Master Plan. Considering that the Digital European Sky programme relies on the execution of phase D of European ATM Master Plan (2020 edition), further described in the SRIA, the project results will focus on deployment planning and monitoring, and will contribute to the following outcomes:

- getting strong buy-in from both public and private decision-makers with regard to the execution of the European ATM Master Plan;
- accelerating market uptake of SESAR Solutions, differentiating voluntary from mandated/regulated deployment actions;

- aligning short-/medium-term deployment activities with the long-term vision outlined in the ATM Master Plan with a particular focus on (1) easing decision-making in relation to the transition from development to deployment and encouraging early movers and (2) monitoring the progress of deployment activities in relation to the vision outlined in the Master Plan
- achieving comprehensive coverage of the deployment phase (i.e. industrialisation and implementation activities)

Scope

The ATM Master Plan is composed of three levels: level 1, executive view; level 2, development planning and reporting; and level 3, deployment planning and reporting. The master planning project will focus on supporting the SESAR 3 JU to plan and report on deployment activities in both industrialisation and implementation. The scope could be extended to supporting the SESAR 3 JU in campaign to update the European ATM Master Plan 2020 level 1, should it be decided to do so. Similarly, some content integration activities could be performed to support the SESAR 3 JU programme management, providing that an efficient methodology be made available. The management of level 2 will be performed by the SESAR 3 JU, and close coordination with the project will take place to ensure due consideration of the link to deployment.

To achieve the expected outcomes, the activities to be performed under the leadership of the SESAR 3 JU will focus on the following areas.

- Main activities:
  - in connection with the network impact assessment results, develop and maintain optimised deployment scenarios for R&I uptake of SESAR Solutions throughout the European network, which will be the basis for the ATM Master Plan level 3 plan;
  - develop and maintain related consolidated CBAs;
  - develop and maintain optimised level 3 performance impact plans on future reference periods (at national and ECAC levels);
  - consolidate and deliver the Master Plan level 3 plan, covering both voluntary (e.g. by early movers) and mandatory (e.g. regulated by Common Project) deployment activities in both industrialisation (in particular standardisation and certification) and implementation;
  - consolidate and deliver the annual Master Plan level 3 report;
  - encourage market uptake, provide support in updating the SESAR Solutions Catalogue, in particular with regard to links to deployment, as a communications and dissemination tool.
- Additional support activities (on the request of the SESAR 3 JU):
  - support the SESAR 3 JU in organising the Master Plan level 1 update campaign;
  - update the deployment and business views for level 1;
  - support the definition of future common project proposals where and when mandated by the European Commission;
  - support other ad hoc strategic planning and monitoring activities (e.g. airspace architecture study-type activities);

- support the alignment of the ICAO aviation system block upgrade with the evolution of the European ATM Master Plan;
- support the SESAR 3 JU in content integration (i.e. modelling and integration of architectural information).

2.3.5.2 *Work Area 2: Industrial research and validation topic addressing the aviation green deal*

Specific conditions for WA2	
Expected EU contribution per project *Indicative budget*	The SESAR 3 JU estimates that a maximum EU contribution of EUR 5.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount. The total indicative budget for this work area is EUR 30.00 million
Type of actions	Research and innovation action (RIA)
Legal and financial set-up of the grant agreements	Grants awarded under this work area will have to submit the following deliverables: • contextual note • Safety and performance requirements & interoperability requirements in the context of the operational service and Environment Description (SPR-Interop/OSED) • Technical specifications and Interface Requirements (TS/IRS) • Validation plan (VALP) • Validation report (VALR) • Cost benefit analysis (CBA) • Standards needs (STAND) • Regulatory needs (REG) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated)
Other requirements	The maximum project duration is 36 months.

2.3.5.2.1 Topic HORIZON-SESAR-2022-DES-IR1-WA2-1: Industrial research and validation for the aviation green deal

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** The introduction of automation and dynamicity will enable AUs to fly trajectories that are closer to optimal, resulting in fuel efficiencies and thus overall emission reductions. Innovative approaches such as wake energy retrieval (WER) will bring additional CO_2 reductions. The proposed concept will open the door to a better understanding of the climate impact of non-CO_2 emissions, especially vis-a vis the trade-off with CO_2. It will also make it possible to mitigate part of the non-CO_2 impact by effectively tackling contrail formation. The concepts addressing the airport environment will enable improvements to local air quality and help to reduce the noise impact on communities neighbouring airports.

- **Capacity.** A high level of automation will make it possible to introduce the proposed concepts without a negative impact on capacity; furthermore, the WER concept will make it possible for aircraft to be closer together in the cruise phase of flight, potentially increasing airspace capacity.
- **Safety.** The development of adequate system support for the new concepts, based on a high level of automation and their validation in an operational environment, will guarantee that safety levels are either maintained or increased.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Eco-friendly trajectories.** When specific conditions are met – typically traffic conditions – an area can be declared eco-friendly by ATC. Eco-friendly operations are implemented with the aim of minimising the flight environmental footprint. Such implementation relies typically on improved collaboration between pilot and controller and/or between controllers in the planning and execution of the flight. Increased flexibility in the management of the flight makes it possible to optimise the flight profile to improve environmental performance. The targeted flexibility may include free lateral or vertical route deviation (without the need to require a new route clearance) for flight optimisation purposes, so that aircraft can, for example, be cleared to cruise at any fixed geometric altitude between two flight levels (thereby avoiding the climb and descent required to maintain a fixed barometric flight level), or freedom to deviate horizontally within a certain area, allowing more effective use of favourable winds. It is expected that eco-friendly operations will initially be implemented in areas or periods of low traffic (e.g. oceanic/remote areas, at high altitude, at night) and later be expanded to areas and periods of higher traffic *(R&I need: new ways of flying)*.
- **Wake Energy Retrieval (WER) in continental en-route airspace.** WER is an ADS-B-in application that allows aircraft to reduce fuel-burn by flying closely behind another aircraft, thus taking advantage of some of the residual lift of the leader. From an ATM point of view, the challenge is to identify WER candidate pairs and manage the rendezvous. In low-density airspace, continental airspace and/or oceanic/remote airspace, previous R&D has shown the feasibility of strategically planning the rendezvous (before departure) and then executing it by adjusting take-off times and speeds, and this concept is ready for demonstration. The industrial research activities in this topic will address the development and validation of a concept of operations for scaling up the WER concept to all en-route operational environments. This should include the dynamic WER concept, whereby ATC dynamically identifies WER candidate pairs among equipped aircraft that are already airborne, rather than before departure. The inclusion of WER equipage information in the flight plan will need to be addressed. Tools for monitoring network WER operations for performance assessment purposes are also in scope. For situations where a pre-departure planned rendezvous is feasible

and efficient, NM and FMP tools and procedures for rendezvous planning are also in scope *(R&I need: formation flight)*.

- **Development of a meteorological service to publish and dynamically update information on ECHO areas.** This element builds on previous SESAR work on environmental change functions and is aimed at aggregating the environmental impact assessment into a single continuously updated ECHO area publishing service; it may also include the development of required technical enablers (measurement capabilities, aircraft sensors, satellites functions, etc.). ECHO areas are those areas of the airspace where there is a high degree of certainty that aircraft emissions would cause a disproportionately high environmental impact due to aviation-induced cloudiness with a warming effect *(R&I need: non-CO_2 impacts of aviation)*.
- **ECHO area avoidance in the planning and execution phase.** This element is expected to use SESAR knowledge on avoidance of dynamic mobile areas (DMAs) (with the areas to be avoided in this case being ECHO areas rather than military training areas). The objective is to develop a concept of operations that encompasses both the planning phase (so that AUs can plan their flights to avoid entering published predicted ECHO areas) and the execution phase (during which controllers will have on-screen information on ECHO area evolution in real time and will deliver the necessary clearances to ensure that aircraft do not enter them). The concept addresses the NM flight plan validation and DCB processes, as well as the FMP and ATC aspects of the execution phase. The environmental benefits will be measured in real time and made available to AUs and the general public through the ANSP environmental dashboard *(R&I need: non-CO_2 impacts of aviation)*.
- **Improved vertical trajectories on climb and arrival through new avionics and novel air–ground synchronisation.** This element builds on previous SESAR 2020 work on the development of permanent resume trajectory avionics and new air–ground data exchanges that enable flight crews visibility of the ATC plan for their flight, which they can use to better plan their descent profile. It also includes improvements to the connectivity between the electronic flight bag (EFB) and the FMS as an enabler *(R&I need: environmentally optimised climb and descent operations)*.
- **Enhanced vertical clearances.** This element is based on the uplink of vertical constraints via CPDLC in order to ensure separation with potentially conflicting aircraft. This concept will enable a drastic reduction in the number of level-offs during climb and descent. It is expected that the first benefits can be realised without new avionics developments, but, in order to fully realise the benefits, improvements to the on-board avionics (FMS and/or EFB) and procedures for the management of vertical constraints may be required *(R&I need: environmentally optimised climb and descent operations)*.
- **Systemised airspace route structures with dynamic allocation of standard arrival routes (STARs).** This element addresses procedures and system support to allocate aircraft in one of two or more almost parallel STARs before top of descent (TOD), so that aircraft have lateral separation and therefore the need for vertical constraints during the descent is reduced. The implementation of this concept in the European environment will require cross-border collaboration, and it is therefore essential that this aspect is covered. The concept may be combined with the intermediate AMAN gates concept, based on the introduction of one or more metering fixes before the final metering fix that AMAN builds a sequence for *(R&I need: environmentally optimised climb and descent operations)*.

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- **Introduction of dynamicity in the use of RNP route structures.** This element will develop and validate a concept for RNP route structures (trombones, point merge or other) to be activated or deactivated depending, for example, on the time of day, for noise control purposes, or depending on demand, so that the use of more complex route structures is avoided during periods of low demand. The research needs to address the end-to-end concept, including cross-border aspects and the delivery of the appropriate STAR clearance to each aircraft via voice or CPDLC. Please note that this concept addresses only standard instrument departures (SIDs) and STARs above 3 000 ft (where noise may be a factor but local air quality is not) *(R&I need: environmentally optimised climb and descent operations)*.
- **Improved airport environment through dynamic SID and noise abatement departure procedure (NADP) allocation.** This element includes the definition of new NADP concepts and a combined SID and NADP allocation concept that will be based on the optimisation of environmental impact functions taking into account potential trade-offs between local capacity, local air quality, noise impacts in the area around the airport and impact on the climate at global level. It is anticipated that there will be an initial concept in which the SID scheme is established in advance (e.g. 4 hours in advance), based on the predictions made by meteorological services, and published so that AUs can take it into account in their flight plans. In the longer term, the allocation will be done on a case-by-case basis and more dynamically (up to just before the aircraft leaves the gate) *(R&I need: non-CO_2 impacts of aviation)*.
- **New avionics in support of improved speed and aircraft configuration management on arrival.** This elements covers the development of avionics (EFB and/or FMS) in support of improved speed and aircraft configuration management (e.g. in relation to throttle and control surfaces, including in particular high-lift device and landing gear extension management). The research will cover operations on both the cockpit and the ATC side; it will assess impact on ATC TMA and approach procedures and if necessary develop new guidance, procedures, phraseology and/or support tools for TMA controllers) *(R&I need: advanced RNP green approaches)*
- **Green ATC capacity concept.** This research will investigate the concept of green ATC capacity, whereby, when the ATC capacity of a sector/airport is calibrated, in addition to the maximum capacity (including sustain and peak concepts), a (lower) maximum green capacity is used to represent the maximum sector load or arrival capacity for which ATC can facilitate environmentally optimised trajectories. Specific metrics could be investigated in addition to the usual metrics used in DCB and ATC. Green ATC capacity is expected to support improved ANSP decision-making in the area of sector configuration in real time (with a link to dynamic airspace configurations) and also in the area of strategic capacity planning, including impact assessments on building new runways *(R&I need: new ways of flying)*.
- **Local (airport/TMA), ATSU-level and network-wide digital environmental performance dashboards.** Building on previous environmental performance monitoring initiatives such as existing airport local air quality and noise monitoring programmes and the existing European continuous climb and descent operations monitoring dashboard, this validation exercise will accelerate the deployment of environmental performance monitoring dashboards across Europe. The aim is not only to provide visibility of environmental metrics but also to support their progressive integration into the decision-making process at strategic, pre-tactical and tactical levels, including the

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consideration of trade-offs with other performance indicators. The first pre-tactical and tactical integration applications are envisaged in the area of total airport management, and concern runway and taxiway use. The validation is expected to incorporate existing metrics and expand the environmental impact assessment toolbox by developing novel metrics to provide a more complete picture of the impact of aviation on the environment than is possible today. New metrics of interest include, for example, metrics for non-CO_2 impacts and metrics to capture the inefficiencies caused by early descent (time from TOD to landing, difference between actual and EPP TOD, etc.), and aggregated horizontal and vertical efficiency metrics (3Di indicators, trajectory-based indicators, etc.). Special attention should be paid to ensuring that environmental performance dashboards make visible trade-offs between different environmental impacts (fuel, noise, local air quality, climate change), and also between environmental impacts and other performance indicators (capacity). The information from the environmental dashboards that is relevant to the public will be made publicly available to all European citizens (*R&I need: accelerating decarbonisation through operational and business incentivisation*).

- **Advanced calibration of airport capacity.** The ATFM declared capacity of an airport is the maximum number of aircraft that can be allocated a pre-departure target time for arrival in a given time slot. It takes into account runway throughput and the uncertainty of traffic demand data: the higher the uncertainty, the higher the buffer in the declared capacity needs must be in order to ensure that there will be no holes in the sequence due to under-delivery. This element will develop a solution aimed at leveraging the reduced traffic uncertainty brought about by SESAR ATFM developments by reducing the declared capacity buffer without effectively reducing real capacity or traffic movements. Thanks to the reduced buffer, aircraft will experience shorter arrival sequencing and metering area delays, which will result in environmental benefits *(R&I need: new ways of flying)*.
- **Engine-off absorption of AMAN/STAM/vSTAM departure delay.** These demonstrators will integrate green taxi concepts with the synchronisation of the engine start-up and target time for take-off in the case of ground delay at short notice due to AMAN/STAM/vSTAM. They will address medium and large airport environments, and in particular the challenges posed when the departure airport is a large CDM airport with a complex departure sequence implementation process and when arrival traffic loads are high; it is in precisely in these challenging conditions that the potential benefits for the environment are greatest *(R&I need: new ways of flying)*.

2.3.5.3 *Work Area 3: Industrial research and validation topics*

Specific conditions for WA3	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 12.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 55.00 million
Type of actions	Research and innovation action (RIA)

Legal and financial set-up of the grant agreements	Grants awarded under this work area will have to submit the following deliverables: • contextual note • Safety and performance requirements & interoperability requirements in the context of the operational service and environment description (SPR-Interop/OSED) • Technical specifications and interface requirements (TS/IRS) • Validation plan (VALP) • Validation report (VALR) • Cost benefit analysis (CBA) • Standards needs (STAND) • Regulatory needs (REG) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated)
Other requirements	The maximum project duration is 36 months.

This work area will focus on the delivery of the next generation of enabling platforms and services with a view to achieving the ambition of the Digital European Sky.

2.3.5.3.1 *Topic HORIZON-SESAR-2022-DES-IR1-WA3-1: Industrial research and validation for connected and automated ATM*

This topic addresses the research needed to achieve automation level 4 (high automation) across the European ATC platforms. As described in the European ATM Master Plan 2020, this high level of automation supports the human operator in information acquisition and exchange, information analysis, action selection and action implementation for all tasks/functions. Automation can also initiate action for most tasks.

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Improvements to connectivity and automation will enable ATM to facilitate more efficient ground operations and air trajectories that are closer to the optimum, thus limiting emissions, decreasing noise and improving local air quality.
- **Capacity.** The safe use of less restrictive separation modes, combined with an increased level of automation support to ATC, will optimise the use of the airspace. Improvements in the predictability of ground operations and the integration of advanced tools for arrival and departure will help to optimise runway use. Better connectivity between stakeholders, the use of shared 4D trajectories, interoperability and a higher degree of predictability brought about by increased automation will increase capacity.
- **Cost-efficiency.** The implementation of higher levels of automation, when adopted consistently, will contribute to operational harmonisation and eventually to cost-

efficiency. A service-based approach and a well-defined required service level (e.g. for CNS services) will also help to achieve cost-efficiencies.

- **Operational efficiency.** Shared 4D trajectories and interoperability will increase predictability, enabling preferred trajectories to be flown with fewer tactical interventions.
- **Safety.** The performance of the system (human and automated elements) in an environment with increased automation includes its safety performance, which will be maintained if not improved. The automation of some procedures will ultimately lead to improved safety and fewer errors, which tend to be triggered by humans. Additionally, increased data-sharing will foster the early detection of potential safety issues and their mitigation.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Next generation ATC platforms for en-route and TMA operations.** This element will involve the development of integrated ATC platforms leveraging state-of-the-art technologies to deliver level 4 automation functionalities for en-route and approach operations. The R&I results will enable the full implementation of the target architecture as set out in the European ATM Master Plan (virtualisation, TBO, etc.) as well as concepts such as platform as a service to facilitate the complete decoupling of service provision (infrastructure services, information services and all other ANSs) from the physical location of the infrastructure, as outlined in the target architecture specified in the European ATM Master Plan *(R&I needs: advanced separation management; intelligent queue management; integration of safety nets; role of the human; speech recognition for increased safety and reduced workload; integration of safety nets (ground and airborne) with the separation management function)*. It includes, for example, the following features:
  - automatic delivery of ATC instructions and clearances;
  - advanced automation support for separation management (e.g. automated conflict detection and resolution using AI-powered digital assistants);
  - integration of (ground and airborne) safety nets with the separation management function;
  - air–ground 4D trajectory synchronisation for automated detection, classification, resolution and monitoring of conflicting profiles in the planning and tactical phases of ATM;
  - system health monitoring, service quality level and degradation management of distributed architectures;
  - integration of new aircraft types (e.g. RPAS, VTOL, hydrogen aircraft, electric aircraft);
  - use of advanced HMI interaction modes (e.g. multi-touch interaction, automatic speech recognition, virtual tracking labels, interaction based on air gestures, attention guidance and control, virtual reality, resilient synthetic vision tools, augmented reality) for innovative en-route and TMA applications;
  - intelligent queue management (e.g. using ML and big data techniques);

- consideration of the role of the human in the new joint human–machine cognitive system, and in particular resource management aspects in the context of new business models, distributed architectures and the paradigm change in service provision;
- automation in support of new ATM concepts aimed at increasing runway throughput (e.g. optimised wake separation).

- **Next generation ATC platforms for airport operations:** This element will involve the development of integrated ATC platforms leveraging state-of-the-art technologies to deliver level 4 automation functionalities for airport operations. The R&I results will enable the full implementation of the target architecture as set out in the European ATM Master Plan (virtualisation, TBO, etc.) as well as concepts such as platform as a service to facilitate the complete decoupling of service provision (infrastructure services, information services and all other ANSs) from the physical location of the infrastructure, as outlined in the target architecture specified in the European ATM Master Plan *(R&I needs: airport automation including runway and surface movement assistance for more predictable ground operations; runway use optimisation through integrated use of arrival and departure TBS tools; intelligent queue management; role of the human; speech recognition for increased safety and reduced workload)*. It includes, for example, the following features:
  - automated delivery of apron advisories and ATC clearances;
  - use of advanced HMI interaction modes (e.g. multi-touch interaction, automatic speech recognition, virtual tracking labels, interaction based on air gestures, attention guidance and control, virtual reality, resilient synthetic vision tools, augmented reality) for innovative airport applications;
  - support for airport operations in all-weather conditions while maintaining a high runway throughput, equivalent to what is possible in good visibility;
  - runway and surface movement assistance for more predictable ground operations (e.g. automation of stand planning, taxi routing and ground de-confliction, and runway use optimisation);
  - automated ground handling operations (e.g. autonomous airside operations) and safety nets;
  - runway use optimisation through integrated use of arrival and departure TBS tools;
  - intelligent queue management (e.g. using ML and big data techniques);
  - consideration of the role of the human in the new joint human–machine cognitive system.
- **Next generation applications for network operations.** This element will involve the development of level 4 automation functionalities for network operations leveraging state-of-the-art technologies and capabilities. It includes, for example, network-wide synchronisation of 4D trajectory information and providing trajectory advice (including uncertainty considerations and improved weather forecasts) to ATCOs for human confirmation or automatic implementation. *(R&I need: network-wide synchronisation of trajectory information)*.
- **Future connectivity and digital infrastructure.** This element will involve the development of solutions for hyper-connectivity between all stakeholders (ground–ground and air–ground) via high-bandwidth, low-latency fixed and mobile networks

leveraging state-of-the-art technologies (e.g. broadband connectivity, cloud services, IoT) and the delivery of the digital backbone infrastructure (CNS and beyond) required by digital European sky applications. The R&I results will enable the full implementation of concepts such as infrastructure as a service to facilitate the complete decoupling of service provision (infrastructure services, information services and all other ANSs) from the physical location of the infrastructure, as outlined in the target architecture specified in the European ATM Master Plan *(R&I need: enabling the deployment of a performance-based CNS service offer)*. It includes, for example, the following features:

- enabling the deployment of a performance-based CNS service offer and transitioning to data services;
- development of integrated, digital CNS solutions (e.g. LDACS, satellite-based CNS);
- data communication as the primary means of air–ground connectivity;
- solutions for air–ground connectivity and dialogue between air and ground digital assistants;
- a move from VHF voice to digital voice for controller–pilot communications;
- development of IoT for aviation (machine-to-machine communication for real-time and automatic decision-making);
- development of fully IP-based communications and use of higher bandwidth mobile networks, including satellite-based solutions;
- development of non-safety-of-life ATM applications using commercially available services (e.g. 5G, open satellite communications (SatCom)) required for hyper-connected ATM;
- air–ground and ground–ground data communication solutions for RPAS (including remote pilot–controller voice and CPDLC communications);
- operational use of datalink on the airport surface, incorporating the ICAO's flight and flow information for a collaborative environment (FF-ICE) TBO concept;
- development of advanced applications of the SWIM technical infrastructure;
- automation of next generation ATC platforms underlying technical processes (e.g. cybersecurity, maintenance, dataset updates).

2.3.5.3.2 Topic HORIZON-SESAR-2022-DES-IR1-WA3-2: Industrial research and validation for air–ground integration and autonomy

The current ATM system and technologies are not designed to allow the accommodation or full integration of an increasing number of new forms of mobility and air vehicles that have a high degree of autonomy and use digital means of communication and navigation. This topic covers the industrial research required for the evolution of technologies and operational concepts in order to address this need.

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Optimised operations due to integrated 4D trajectory operations contribute to the related optimisation of fuel-burn and therefore of overall emissions per flight.
- **Capacity.** The main objective of the integration is to maintain capacity even following important changes in fleets (i.e. a shift from manned to unmanned).
- **Cost-efficiency.** Increased air–ground integration as per FF-ICE TBO supports the introduction of higher levels of automation in ATM; the implementation of higher levels of automation, when adopted consistently, will contribute to operational harmonisation and eventually to the cost-efficiency of the ATM system. A service-based approach and a well-defined required service level (e.g. for CNS services) will also help to achieve cost-efficiencies. Developments on the cockpit side will support a reduced crew operations concept, potentially unlocking significant cost savings for AUs.
- **Operational efficiency.** Advanced communication means (e.g. agile frequency transfer, system-to-system dialogues) and increased automation (reduced workload for ATCOs and flight crews/remote pilots) will contribute to increased operational efficiency. Trajectory management as per the FF-ICE 2 TBO concept will improve flight efficiency, particularly in the vertical domain, and reduce cruising/taxiing fuel consumption when flights are subject to queuing.
- **Safety.** Operational safety is positively impacted by the design of new operations providing advanced separation management; increased automation enables human actors to be discharged from routine tasks and to focus on strategic tasks, including oversight of the safety of operations.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Next generation airborne avionics platforms enabling autonomy:** This element will involve the development of integrated airborne avionics platforms leveraging state-of-the-art technologies and enabling the safe integration of autonomous airborne operations (single-pilot operations, RPAS and HAO) into the ATM system *(R&I needs: single-pilot operations; enabling greater ground and airborne integration and wider performance; integration of drones into all classes of airspace; super-high-altitude-operating aerial vehicles)*. It includes, for example, the following features.
  - Advanced airborne systems supporting single-pilot operations: in order to operate safely with a reduced crew, safety systems will be a key enabler to trigger back-up modes in case of incapacitation, stress or exhaustion of crew members. This involves the development of systems such as augmented and virtual reality for smart/enhanced visual operations, airborne digital assistants, connected FMS, multi-sensor navigation, airborne collision avoidance, automated ATC communication and frequency management.
  - Autonomous navigation in all phases of flight (landing, taxi and take-off, approach in all conditions with limited ground infrastructure).
  - Advanced airborne systems supporting RPAS and HAO integration into ATM, such as data communication, airborne safety nets, DAA and remain well clear functionalities.

- **Air–ground integration enabling future operations.** This element will involve the development of operational solutions allowing for the safe integration of autonomous airborne operations (single-pilot operations, RPAS and HAO) into the ATM system *(R&I needs: single-pilot operations; enabling greater ground and airborne integration and wider performance; integration of drones into all classes of airspace; super-high-altitude-operating aerial vehicles)*. It includes, for example, the following.
  - **Operations for safe return to land in single-pilot operations.** This will involve the specification of the conditions under which pilot incapacitation is declared and how this is handled by the various actors involved (including in the aircraft, the airline operation centre and ATM) and of the role of the ground assistant when the pilot is in command.
  - **Operations for FOC–wing operations centre (WOC)–ATC connectivity in single-pilot operations.** This will involve addressing the expected role of the FOC/WOC in the case of abnormal situations involving single-pilot operations requiring their connection to ATC centres to support safe return to land, even in a congested traffic environment.
  - **Operations enabling the integration of drones into all classes of airspace.** This covers the integration with cooperative and non-cooperative traffic of small vehicles mainly operating at very low level close to urban areas and airports, as well as large vehicles, such as RPAS, used for both civil and military applications.
  - **Operations for super-high-altitude-operating aerial vehicles.** This involves safe and efficient separation management and entry and exit procedures through segregated or non-segregated airspace.
- **Operations for safe dialogue between controller and pilot with ML and speech-to-text-to-speech techniques** *(R&I needs: integrated 4D trajectory automation in support of TBOs; enabling greater ground and airborne integration and wider performance; complex digital clearances)*. The aim is to:
  - replace the controller's voice with messages that can be directly understood and executed by on-board avionics, reducing the execution time for controller directives and misunderstandings on the part of pilots;
  - perform surveillance of pilot–controller dialogues, in order to detect any misunderstanding between them.
- **Integrated 4D trajectory automation in support of TBOs.** This element will involve the development of a common 4D trajectory, shared between every application that needs to process each flight, and updated by every application acting upon that flight, to underpin ground-provided ATM information *(R&I needs: integrated 4D trajectory automation in support of TBOs; ATM–U-space convergence; enabling greater ground and airborne integration and wider performance; complex digital clearances)*. It includes, for example:
  - applications for 4D trajectory synchronisation and ATM–U-space convergence to facilitate access and operations in controlled airspace;
  - trajectory management during the execution phase, including a contribution to the development of the ICAO's FF-ICE 2 TBO concept;
  - gate-to-gate data-driven trajectory prediction and conflict detection/resolution.

2.3.5.3.3 *Topic HORIZON-SESAR-2022-DES-IR1-WA3-3: Industrial research and validation for capacity on demand and dynamic airspace*

This topic covers the industrial research required in support of the scalable capacity concept, which requires agility and flexibility in providing capacity where and when it is needed, particularly to maximise the use and performance of limited resources (i.e. airspace and ATCOs). It includes both an increase in the volume of air traffic that can be safely managed per volume of airspace and increased flexibility in the allocation of the controller workforce to offer ATC capacity where it is needed through the virtualisation of ATC provision. The increased capacity will not result in reduced flight efficiency (i.e. the optimisation of trajectories will be possible even at busy periods).

Expected outcomes

The introduction of dynamicity in the management of airspace and the capacity-on-demand service will unlock performance benefits in the following areas.

- **Environment.** More precise trajectories for arrival and departure will make it possible to reduce noise impact.
- **Capacity.** Capacity is measured in terms of either ATFM delays (lack of capacity) or throughput. En-route capacity aims to maintain ATFM delays at 0.5 minutes per flight or less. TMA and peak runway throughput will be increased according to traffic forecasts. A more stable and predictable level of capacity will be achieved in all-weather operations. In addition, by providing capacity dynamically where and when it is needed and reconfiguring the airspace to match traffic flows, overall system resilience will be significantly increased.
- **Cost-efficiency.** Dynamic airspace configurations, capacity on demand and ATCO training programmes will provide scalability. ATCO productivity is expected to increase significantly.
- **Operational efficiency.** Trajectory management and dynamic airspace configurations will provide further improvements in vertical flight efficiency and cruising/taxiing fuel consumption when flights are subject to queueing. Overall improvements in capacity and trajectory management and use of dynamic airspace configurations are expected to reduce the average delay in block-to-block times by 4 minutes per flight.
- **Safety.** Safety levels will be maintained.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Applications for resilient, cross-border, on-demand ATSs and dynamic airspace management.** This will involve the development of applications leveraging state-of-the-art technologies to deliver resilient, cross-border, on-demand ATSs and dynamic airspace management *(R&I needs: on-demand ATSs; ATM continuity of service despite disruption)*. It includes, for example:
  - flexible allocation of resources to where they are required based on traffic demand, irrespective of the controller's physical location in Europe, while taking into account network optimisation needs;
  - reconfiguration/consolidation of cross-border dynamics and remote ATSs, including the development of operational plans for flexible and dynamic sectorisation taking

into account basic complexity indicators based on specific shapes of demand, network flight efficiency needs and existing ATC technology-enabled capabilities, and the application of the virtual centre concept, as well as the operation in real time of the concept;

- a network performance management cockpit that supports CDM to improve the current monitoring process, combining collected local performance indicators and the use of advanced data science and prediction techniques allowing the identification of unattended business opportunities and the anticipation (and better management) of disruptive operational situations across the network;
- cross-border flow-centric operations, including full reconciliation of ATFCM measures with other measures/advisories and multiple constraint management., as well as dynamic sector configurations that satisfy traffic flows and are adaptable and proportionate to variable traffic demand;
- increased flexibility in ATCO validations for a generic pan-European capacity-on-demand service;
- a resilient ATM system that continues to provide services despite disruption, for example during capacity bottlenecks, adverse weather or national system breakdowns;
- system health monitoring, tools and procedures for resilience and containment of potential cascade failures in geographically distributed interconnected and interdependent systems.

2.3.5.3.4 *Topic HORIZON-SESAR-2022-DES-IR1-WA3-4: Industrial research and validation for AI for aviation*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** AI will enable the optimisation of aircraft trajectories, potentially reducing the aviation environmental footprint.
- **Capacity.** AI will play a fundamental role in aviation/ATM to address airspace capacity shortages, enabling dynamic configuration of the airspace and allowing dynamic spacing separation between aircraft.
- **Cost-efficiency.** AI will enrich aviation datasets with new types of datasets, unlocking air–ground AI-based applications, fostering data-sharing and building up an inclusive AI aviation–ATM partnership. This will support decision-makers, pilots, ATCOs and other stakeholders, bringing benefits in cost-efficiency by increasing ATCO productivity (reducing workload and increasing complexity capabilities).
- **Operational efficiency.** Increasing predictability will be a key function of AI, as it will enable traffic predictions and forecasts that will boost punctuality.
- **Safety.** Safety science will need to evolve to cope with the safety challenges posed by the introduction of ML. Current safety levels will be at least maintained using this technology.
- **Security.** AI will make it possible to stay cyber-resilient in the face of new technologies and threats; the objective is to maintain a high level of security.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **AI-powered applications for higher levels of automation.** This will involve the development of AI-powered applications supporting the transition to automation level 4 *(R&I needs: trustworthy AI-powered ATM environment; AI for prescriptive aviation)*. It includes, for example, the following features.
  - **AI-powered applications supporting next generation ATC platforms.** The research will involve the development of innovative AI applications and advanced HMI for ground systems. This includes support tools for complex operations as well as for the safe integration of new entrant aircraft types (i.e. UAVs, supersonic aircraft, hybrid and fully electric aircraft) into an increasingly busy, heterogeneous and complex traffic mix.
  - **AI-powered applications supporting next generation airborne platforms.** The research will involve the development of intelligent augmentation tools enabling autonomous operations (e.g. vision-based navigation or trajectory optimisation).
- **AI development infrastructure and services.** This relates to the development of an appropriate aviation/ATM AI infrastructure supporting AI-enabled applications, with the required software development processes, using robust architectures for ATC systems to provide ATCOs and pilots with a good level of confidence in automated decision-aiding tools *(R&I needs: trustworthy AI-powered ATM environment; AI for prescriptive aviation; AI Improved datasets for better airborne operations)*. It includes, for example, the following features.
  - **Cloud infrastructure and services.** The research will involve the development of an AI-powered cloud infrastructure and services for automation level 4 and above. This will include the development of ATM processes from which analysis and prediction are particularly likely to benefit.
  - **Trustworthiness and explainability.** The research will involve the development of new methodologies for the validation and certification of advanced automation, including in relation to cybersecurity that ensures transparency, legal aspects, and robustness and stability under all conditions. The methodologies should take into full consideration a future ATM environment built on multiple AI algorithms, a system of systems with a human-centric approach. They should also cover abnormal situation management.
- **AI-powered digital assistants.** With a view to achieving automation level 4, this element will involve the development of human–machine joint cognitive systems in which a digital assistant proposes the best possible options to the human (with regard to flows, sequences, safety nets, etc.) and solves complex situations using machine-to-machine communication *(R&I need: human–AI collaboration: digital assistants)*. It includes, for example, the following features.
  - **Airborne digital assistant.** The results of the research will support pilots and reduce their workload (e.g. by automating non-critical tasks and adapting the HMI during operations). This is a first step towards introducing the artificial co-pilot necessary for future operations such as single-pilot operations.

- **Ground digital assistant.** The research will contribute to increasing ground operators' (e.g. ATCOs') capabilities during complex scenarios and reducing workload in order to allow them to focus on high-added-value activities and strategic planning, for example by proposing the best possible options to the controller (with regard to flows, sequences, safety nets, etc.) while solving complex trajectory situations using machine-to-machine communication between airspace users. AI-based human operator support tools that ensure the safe integration of new entrant aircraft types into an increasingly busy, heterogeneous and complex traffic mix (i.e. UAVs, supersonic aircraft, hybrid and fully electric aircraft) should be developed.
- **Air–ground synchronisation.** The research will involve the development of air–ground applications to automatically negotiate trajectory changes and achieve the best possible air traffic patterns (for environmental sustainability, safety, etc.).
- **Intelligent training systems.** This covers the design and implementation of intelligent systems to perform automated ATCO training, including the use of AI-based techniques to evaluate actions and enhance skills in a tailored fashion.

2.3.5.3.5 *Topic HORIZON-SESAR-2022-DES-IR1-WA3-5: Industrial research and validation for civil–military interoperability and coordination*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Greater predictability resulting from the integration of military flight data into the network will lead to more efficient use of available airspace capacity by civil traffic, which will lead to greater fuel efficiency.
- **Capacity.** Greater predictability resulting from the integration of military flight data into the network will lead to more efficient use of available airspace capacity by civil traffic, which will lead to fewer delays.
- **Operational efficiency.** Greater mission predictability will be of benefit to the operational efficiency of civil traffic in the European network.
- **Security.** The confidentiality, integrity and availability of information and data are crucial in ensuring safe and secure military operations. The development of a secure virtual infrastructure will address the issue of fragmentation, while digital technologies are viable options for enhancing the resilience of infrastructure to cyberattacks.
- **Civil–military coordination.** The transmission of shareable data relating to mission trajectories to the NM will ensure the optimal and timely integration of military flight data into the network, thus allowing solid and reliable traffic predictions.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Access to airspace.** This element will involve further develop the seamless access to airspace to both civil and military users *(R&I need: access to airspace and SWIM)*. It includes, for example, the following features:
  - **Advanced dynamic mobile areas.** This will support dynamic configuration of segregated airspace and management of mission trajectories, thus contributing to the

efficiency of both civil and military operations. The areas will have the potential to 'roll up' following use over time, distance and volume as a mission progresses, allowing the early release of airspace for other users. The concept of dynamic mobile areas reduces the need for static airspace reservation, as it protects the aircraft along its trajectory, not linked to any geographical location.

- ○ **Mission trajectory management.** The research will result in automated support for civil–military CDM processes supported by common procedures and data formats and the underlying information exchange services.
- ○ **Interoperability with U-space.** This will require the development of specifications and procedures enabling U-space permeability to mission trajectory and mixed-mode operations, together with the required civil–military interoperability concerning certified UASs.

- **Data-sharing.** This refers to the availability of data (e.g. aeronautical, meteorological, environmental and flight data) in a digital format to improve air picture development *(R&I need: military surveillance capabilities)*.
- **Military surveillance capabilities.** This refers to the availability of data (e.g. aeronautical, meteorological, environmental and flight data) in a digital format to improve military surveillance capabilities (*R&I need: military surveillance capabilities)*.
- **Connectivity and access to CNS infrastructure.** This refers to the development of a service-driven approach to the CNS infrastructure that accommodates both civil and military needs *(R&I need: connectivity and access to CNS infrastructure)*. It includes, for example, the following features.
  - ○ **Joint utilisation of the CNS infrastructure.** This refers to the development of technologies enabling joint civil and military utilisation of the CNS infrastructure and improvements to how CNS services are delivered, including cross-domain services (e.g. contingencies).
  - ○ **Avionics interoperability.** This will require solutions allowing CNS avionics (e.g. using software-defined radios) to operate seamlessly and to be interoperable with civilian CNS requirements.
- **Cybersecurity.** This refers to the development of cybersecurity and data protection solutions, which should be considered holistically as part of an end-to-end information management process. This includes personnel education, training and capacity building, and changes to technical infrastructure in the context of increased cooperation and information-sharing among civil and military authorities. It also includes addressing potential combined attack scenarios involving signal in space attack vectors *(R&I need: cybersecurity)*.

2.3.5.4 ***Work Area 6: IR topics addressing key SESAR 2020 solutions required to complete ATM Master Plan phase C (only in IR1 call)***

Specific conditions for WA6	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 5.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.

Indicative budget	The total indicative budget for this work area is EUR 25.00 million
Type of actions	Research and innovation action (RIA)
Legal and financial set-up of the grant agreements	Grants awarded under this topic will have to submit the following deliverables: • contextual note • Safety and Performance Requirements & Interoperability Requirements in the context of the Operational Service and Environment Description (SPR-Interop/OSED) • Technical Specifications and Interface Requirements (TS/IRS) • Validation Plan (VALP) • Validation report (VALR) • Cost Benefit Analysis (CBA) • Standards needs (STAND) • Regulatory needs (REG) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated)
Other requirements	The maximum project duration is 36 months.

This work area comprises the industrial research activities required to achieve TRL6 for the key R&D solutions that make up the European ATM Master Plan 2020 phase C ambition, establishing a solid foundation for ATM Master Plan phase D. The scope of this work area includes a number of elements that, although addressed by SESAR 2020 wave 1 and wave 2 activities, did not finally reach TRL6. It also covers the integration of solutions that, having achieved (or nearly achieved) TRL6 as part of previous SESAR programmes, still require integrated validation activities to facilitate and de-risk the industrialisation and deployment phases: these activities may target a TRL7 level of maturity. It may also include activities for the early integration of less mature SESAR Solutions.

By the end of phase C, the ATM system will have gradually integrated greater levels of automation and connectivity (levels 2 and 3), supporting higher productivity and full sharing of information among stakeholders. It will be using standardised and interoperable systems enabling TBOs in a highly connected, service-oriented, network-driven context. The collaborative planning and decision process will allow each flight to be managed and optimised as a whole rather than in relation to segmented portions of its trajectory. This phase will also see the full integration of airports into the ATM network, facilitating airspace user operations and thereby reducing the impact of ATM on user costs. This will be possible thanks to the involvement of airspace user / flight operations centres, dynamic DCB management, and further integration of ATC and ATFCM. The data provided through ATM data service providers (ADSPs) and a more flexible system with improved and new services, such as capacity on demand, will fully support the implementation of these operations. This integration will certainly be gradual; it may start at a regional level or with some alliances of ANSPs.

The new architecture will make it possible to decouple the system infrastructure from ATC operations. ANSPs, irrespective of national borders, will be able to plug in their services where they are needed, providing end-to-end services and sharing resources among ANSPs.

In this phase, drone operations (UAS and RPAS) could be managed as routine operations, even if they are not yet fully integrated into ATM. Additional services, along with new ground and air capabilities, will make it possible to manage safely a large number of diverse drone operations in all environments, including urban areas, for which specific requirements will be established.

2.3.5.4.1 *Topic HORIZON-SESAR-2022-DES-IR1-WA6-1: Industrial research and validation for Master Plan phase C connected and automated ATM*

The key objective of this topic is to achieve TRL6 maturity level for the levels of automation and connectivity expected in phase C of the ATM Master Plan 2020 (levels 2 and 3), supporting higher productivity and improved sharing of information among stakeholders, thus building a solid foundation for phase D. The scope is limited to those SESAR solutions identified as 'key' in the European ATM Master Plan 2020. It also covers the integration of solutions that, having achieved (or nearly achieved) TRL6 as part of previous SESAR programmes, still require integrated validation activities to facilitate and de-risk the industrialisation and deployment phases: the projects addressing these integrated validations will target a TRL7 level of maturity. It may also include activities for the early integration of less mature SESAR Solutions.

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Improvements to connectivity and automation will enable ATM to facilitate trajectories that are closer to the optimum green profile.
- **Capacity.** The increased level of automation support to ATC (level 2 and level 3) will improve the use of the airspace. The increased predictability of ground operations and the integration of advanced tools for arrival and departure will help to optimise runway use. Better connectivity between stakeholders, the use of shared 4D trajectories, interoperability and greater predictability brought about by increased automation will increase capacity.
- **Cost-efficiency.** The objective is to achieve automation level 2 or 3 for ATC platforms, such that there is a high level of automation support for action execution but actions are always initiated by the human controller. This will contribute to improve ATM cost-efficiency. A performance- and service-based CNS infrastructure will also contribute to improve cost-efficiency.
- **Operational efficiency.** Shared 4D trajectories and higher interoperability will increase the predictability of operations, enabling preferred trajectories to be flown with fewer tactical interventions.
- **Safety.** The performance of the system (human and automated elements) in an environment with increased automation includes its safety performance, which will be maintained if not improved. The automation of some procedures will ultimately lead to improved safety and fewer errors, which tend to be triggered by humans.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Future satellite datalink technologies in SatCom Class A.** Achieve TRL6 for future satellite datalink technologies in SatCom Class A for both continental and remote/oceanic regions, including providing support for standardisation on future communications infrastructure multilink if necessary to integrate SatCom Class A technologies *(PJ.14-W2-107)*[48].
- **Combined airborne and ground GBAS approach service type F (GAST-F).** Achieve TRL6 for Galileo-based GAST-D and GAST-F to maximise the benefits of this technology, including for CAT II/III operations, to allow for more robust operations, including at high and low latitudes with tougher ionospheric conditions. This element also addresses increased resilience to radio frequency interference on a single band and increased resilience to single-constellation outages or failures *(PJ.14-W2-79b).* This includes the following elements.
  - Accelerate GAST-D definition, prototyping, testing and validation to incorporate Galileo at a technical level reaching TRL6. The proposal should clearly indicate if the system will simply switch between different satellite constellations or blend satellite signals from different constellations into one navigation system, or both.
  - Develop both the DFMC GBAS ground station and the DFMC GBAS airborne receiver to TRL6 and carry out ground–airborne interoperability testing and performance validation. Note that the DFMC GBAS airborne receiver is not yet at maturity level TRL4, and therefore an essential priority would be developing and maturing it as quickly as possible to catch up with the development of the DFMC GBAS ground station in waves 1 and 2. The proposal should address both ground and airborne aspects, and include Galileo.
  - Set out the specifications, at technical level, for the transition from GAST-D technology (ground–air) to DFMC GBAS. This includes the rapid development and adaptation of GBAS GAST-D to incorporate Galileo (excluding multifrequency signals).
  - Incorporate the findings of the high-level working group on the GAST-F architecture.
  - Develop a prediction service to anticipate CAT II/III unavailability due to atmospheric/solar events and also to provide an estimate of expected performance in terms of minutes of expected unavailability of the service per year, including potential correlation with low-visibility procedures (if there is any). In particular, an alert service that forewarns airspace users in a timely manner of expected outages, prior to the outage actually happening, is necessary for the safe and efficient conduct of flights.
  - Transitional aspects, including downwards compatibility with GAST-D of both ground stations and avionics, need to be addressed. The feasibility of addressing transitional aspects relating to GAST-C needs to be considered.
  - Develop GAST-F based on DFMC, including for CAT II/III operations, for state aircraft operations.
  - Support standardisation and accelerated certification activities, including:
    - the extension of current GBAS CAT III standards (based on Global Positioning System (GPS) level 1 or GLONASS frequency division multiple access) to

(48) Full description of funded SESAR project is available in the SESAR 3 JU website (https://www.sesarju.eu/innovation-pipeline)

accommodate Galileo signals and dual-frequency capability, including the creation of a new ICAO standard in line with the DFMC GBAS concept and the extension of current GAST-D standards to augment Galileo signals;

- the provision of standards that allow the industrialisation of GBAS equipment (ground station and airborne receiver) to ensure the timely delivery and full compatibility of both subsystems;
- Produce minimum operational performance standards for ground and airborne equipment, based on the work of EUROCAE Working Group 28 (in coordination with the Radio Technical Commission for Aeronautics Special Committee 159).

- Develop implementation guidelines, in particular considering different airport layouts / levels of complexity.

- **DFMC GNSS / SBAS / aircraft-based augmentation system (ABAS) receivers.** Achieve TRL6 for DFMC GNSS/SBAS/ABAS receivers and additional avionics systems processing GPS and Galileo signals in L1/E1 and L5/E5, taking into account architectural considerations, assessing transitional aspects, and exploiting synergies and complementarities between different augmentations (DFMC ABAS (advanced receiver autonomous integrity monitoring) and DFMC SBAS) in nominal and degraded modes. This includes consideration of requirements on backwards compatibility and joint airborne architecture for ABAS/SBAS/GBAS receivers / avionics equipment (avoiding the need for multiple avionics) and joint airborne architecture for GAST-F and SBAS. It also includes the development of DFMC GNSS receivers for state aircraft – that is, undertaking standardisation work on the introduction of DFMC GNSS, based on the use of secure signals, for state aircraft operations in a general air traffic environment.
- **LDACS digital voice capability.** Achieve TRL6 for the capability of the future terrestrial air–ground datalink solution (LDACS) to exchange digital voice services. Digital voice is expected to replace VHF radio completely in the long term in all continental operational environments: en route (flight-centric or based on geographical sectors, continental high and low density), TMA and tower, including ground and platform control. The technical solution should be configurable to support both party-line and point-to-point ATC–pilot communication *(PJ.33-W2-02)*.
- **LDACS Navigation (LDACS-NAV) capability.** Achieve TRL6 for LDACS capability as a potential target alternative position, navigation and timing (A-PNT) solution. The objective is to further study LDACS as a complementary system to the current navigation infrastructure, taking advantage of its development as a primary communications system. LDACS is one of most suitable candidates, as it can be easily deployed with distance-measuring equipment (DME) and is a driver for navigation infrastructure rationalisation, capable of meeting RNP 0.3 requirements. This element also covers the avionics required to support the transition from multi-DME to LDACS as an A-PNT solution *(PJ.14-W2-60)*.
- **Integration of various A-PNT technologies.** This refer to supporting performance-based navigation (PBN) / RNP operations in case of a GNSS degradation or outage. Satellite signals from GNSS constellations such as Galileo enable aircraft to follow precise flight paths and take advantage of PBN procedures. Extended periods of signal interruption, for example as a result of signal degradation or satellite outage, can impact flight efficiency. SESAR is researching ways to maintain navigation performance during long-

term signal disruption. Candidate technologies must include LDACS-NAV and may include a multi-DME solution, the receiver autonomous integrity monitoring algorithm, enhanced DME and inertial, alternative radio navigation, or radar and vision technologies including database fusion and inertial, supporting all phases of flight (en route, approach and landing). Although LDACS-NAV is a potential target solution, due to spectrum considerations there will be a need for a transition period during which the number of LDACS ground stations for air–ground COMS will gradually grow. Meanwhile, A-PNT will have to rely on a variable mixture of basic DME navigation, LDACS-NAV, alternative radio navigation, and radar and vision technologies including database fusion. Therefore, the scope of this research includes data fusion of these different sources to enable a seamless transition from DME to LDACS A-PNT. It also includes options for integrating inertial and terrestrial ranging sources using sensor fusion technology (e.g. a new approach to inertial integration based on system-level modularity). The availability of multiple geographical measurements is crucial to integrity, which is based on redundancy. The scope also covers the development of A-PNT solutions for state aircraft operations – that is, use of military inertial systems for state aircraft operations in a PBN/RNP airspace environment for A-PNT purposes. The objective is to achieve TRL6 *(PJ.14-W2-81c and PJ.14-W2-81d)*.

- **SWIM technical infrastructure purple profile for air–ground safety-critical information-sharing.** Achieve TRL6 for SWIM technical infrastructure purple profile for air–ground safety-critical information-sharing, allowing the distribution of safety-critical information through air–ground SWIM infrastructure and Aeronautical Telecommunications Network (ATN) / Internet Protocol suite (IPS) networking, rather than legacy point-to-point contracted services. The outputs should include a roadmap for the transition from legacy protocols to SWIM technical infrastructure purple profile *(PJ.14-W2-100)*.
- **Advanced curved approach operations in the TMA with the use of geometric altimetry.** Complete TRL6 for advanced curved approach operations using geometric altimetry instead of barometric altimetry in the initial, intermediate and final phases of instrument approach operations. The combination of geometric altimetry and curved operations allows optimum flight trajectories and increased safety, efficiency and predictability while reducing the workload of ATCOs and flight crews compared with today's operations *(PJ.01-W2-04.3)*.
- **Enhanced optimised runway delivery for arrivals.** Achieve TRL6 for enhanced optimised separation delivery for arrivals using more accurate flight-specific predictions of final speed profiles derived from either an evolved extended flight plan or an EPP downlinked from the aircraft using ADS-C or advanced big data / ML techniques *(PJ.02-W2-14.6a and PJ.02-W2-14.6b)*.
- **Enhanced optimal separation delivery for departures.** Big data and ML techniques are to be used to make more accurate flight-specific predictions of aircraft performance/behaviour (e.g. rolling distance / rotation point and departure speed / climb profile trajectory) to achieve more efficient spacing between consecutive departures at capacity-constrained airports where complex separation rules are applied. The objective is to complete TRL6 *(PJ.02-W2-14.8)*.
- **Reduction in dynamic pairwise runway separations** (based on ground-computed arrival runway occupancy time and wake-decay acceleration devices). ML techniques are to be used to develop more accurate predictions of arrival runway occupancy time and

runway exit based on aircraft characteristics such as type, weight and equipage (e.g. enhanced versus non-enhanced braking system) and on weather. In addition to improved post-operations offline analysis, ML techniques should lead to an improvement in the quality of arrival runway occupancy time and runway exit predictions during operations. Overall, pairwise runway separations based on ground-computed arrival runway occupancy time will bring benefits in terms of increased runway throughput capacity and resilience, thanks to optimised separation/spacing on the final approach, with a potential positive impact on safety thanks to more accurate predictions of runway exit. The scope also includes the potential use of wake-decay acceleration devices to reduce separation. The objective is to complete TRL6 (*PJ.02-W2-14.10, PJ.02-W2-14.11 and PJ.02-01 (AO-0325)*.

- **Advanced automated support for separation management (levels 2 and 3).** Achieve TRL6 for increased automation solutions (in planning and tactical separation management) including the use of downlinked predicted speed at waypoints, the refinement of the wind model using Mode S reports, and features specific to the tactical trajectory that aim to bring further improvements to conflict detection and resolution tools' performance. Achieve level 2 or 3 of automation for conflict detection and resolution tools, particularly for resolution, to assist the controller in the assimilation of the diverse information that is needed to allow him or her to take optimal decisions taking into account flight efficiency and intent, adverse weather and, ultimately, safety. This also covers the prediction of ATC intent (upstream clearances that have not yet been delivered to the aircraft but that are likely to be delivered to the aircraft by the ground at a later stage) through ML and big data techniques, and performing conflict detection using trajectories calculated using this predicted intent *(PJ.18-W2-53A)*.
- **Collaborative control.** This covers the completion of the collaborative control concepts, which will allow two or more controllers to divide responsibility between them in some cases thanks to advanced system support for coordination. It includes in particular the pull and push coordination concepts, tools and procedures. It will support improved descent profiles thanks to improved coordination methods and a reduced need for aircraft to level off when crossing a sector boundary (because coordinating an aircraft to cross the sector boundary will now be easier) *(PJ.10-W2-73 CC)*.
- **Flight-centric operations in medium density.** This element covers the completion of the IR work on flight-centric operations in the environments identified as of interest at the end of the wave 1 work (as specified in the PJ.10.10-01b datapack, for which this concept reached V2 at the end of wave 1). The scope includes the development of ECAC-wide deployment scenarios that are consistent with the limitations of the VHF spectrum for voice communications (which limit the number of ATC positions that can be operated simultaneously) and the assessment of the ECAC-wide benefits of the concept in each of the deployment scenarios *(PJ.10-W2-73 FCA)*.
- **Virtual/augmented reality applications for tower.** Achieve TRL6 for solutions to support ATCOs by means of virtual and augmented reality applications in the tower environment. The technology involves the use of tracking labels, air gestures and attention guidance *(PJ.05-W2-97.1)*. Operational aspects must be addressed before TRL6 is reached. These applications are enabled by devices such as see-through head-mounted displays that make it possible to:
  - visualise equivalent out-of-the-window view to good visibility even in low-visibility conditions;

  - augment the out-of-the-window view with tracking labels;
  - provide interaction with virtual/augmented reality (V/A-R) interface through air gestures;
  - attract the controller's attention to critical ATC situations.

  The need to switch from head up to head down and vice versa is expected to decrease, with benefits for ATCO productivity and situational awareness.

- **Automatic speech recognition at the tower controller working position, supported by AI and ML.** This element aims to support tower controllers by means of automatic speech recognition supported by AI and ML algorithms, to improve usability and task efficiency. The objective is to achieve TRL6. Note that operational aspects must be addressed before reaching TRL6 *(PJ.05-W2-97.2)*.
- **Interacting with tower CWP by means of touch screen (multi-touch input).** This element aims to support tower controllers by means of a multi-touch input device (touch screen) in addition to traditional means (keyboard, mouse), to improve usability and task efficiency. The objective is to achieve TRL6. Note that operational aspects must be addressed before reaching TRL6 *(PJ.05-W2-97.3)*.
- **Integrated validations of a SESAR airport maximised capacity suite of tools** (based on SESAR 1 and SESAR 2020 wave 1 validated SESAR solutions). The aim is to:
  - showcase the full performance potential that the tools can realise when deployed together in the target environments;
  - de-risk the joint deployment of these solutions and support the creation of a deployment strategy at European level, taking into account specific needs at local level;
  - progress towards TRL7 for the solutions addressed in the integrated validations.
- **Integrated validations of integrated TMA and airport SESAR solutions.** The aim is to facilitate their transition towards industrialisation and deployment. This consists of the integrated validation of TMA and runway SESAR solutions that completed (or nearly completed) TRL6 during the SESAR 1 and SESAR 2020 programmes. They include SESAR solutions for both arrival and departure phases, and their seamless integration with en-route airspace and the network should be ensured. The work should cover filling TRL6 gaps (if any) and should take into consideration any recommendations for future work as documented with regard to these SESAR Solutions during the SESAR 1 and SESAR 2020 programmes, as well as targets for achieving TRL7 maturity. The scope includes support for merging approaching traffic, in combination with extended/streaming AMAN, a TBS tool and PBN routes; synchronisation of arrival and departure flows in high-density/-complexity environments; management of departure flows in an integrated manner enabling a more consistent and manageable delivery into en-route airspace while ensuring optimal usage of runway capacity; digital airborne traffic situational awareness (parallel runways, including closely spaced parallel operations); noise mitigation with advanced GBAS-/SBAS-based procedures (e.g. dual glide slope, instrument guidance system, advanced instrument guidance system); etc. The objective is to:
  - facilitate the transition of the systems to industrialisation and deployment (e.g. specification of the methodology and activities necessary to provide the required

safety evidence to achieve regulatory approval before deployment, contribution to required standardisation activities, data collection campaigns, etc.);

- demonstrate that the integration of these solutions is feasible and will provide the expected performance benefits.

- **Integrated validations of advanced surface management SESAR solutions delivered in SESAR 2020 waves 1 and 2.** The objective is to progress the solutions towards TRL7, includes through:
  - enhanced guidance assistance, in both apron and manoeuvring areas, to vehicle drivers via displays of dynamic traffic context information including the status of runways and taxiways, obstacles and routes by application of an airport moving map, as well as extension of datalink operations to vehicle management to reduce the saturation of sector capacity and/or voice communication channels and avoid potential misunderstandings on the part of vehicle drivers at moments of peak traffic;
  - automatic guidance to mobiles on the airport surface, provided using the 'follow-the-greens' concept and the airfield ground lighting infrastructure;
  - use of real and virtual stop bars appropriately placed in the entire airport movement area to reduce the size of control blocks while ensuring that safe longitudinal spacing is guaranteed between taxiing aircraft, or taxiing aircraft and vehicles, in low-visibility conditions;
  - provision to ATCOs of the most suitable ground routes for all mobiles in the movement area (runways, taxiways and aprons) taking into account user preferences and known constraints (e.g. taxiway closures, aircraft types, etc.).
  - support tools for controllers at airports with advanced surface movement guidance and control systems to detect potential and actual conflict situations, incursions and non-conformance with 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, and generate the corresponding alert.
  - safety support tools for ATCOs and flight crew to reduce the number of runway excursions.
- **Integrated validation of ATFCM, queue management and airport management solutions.** The research should result in integrated validation of delivered SESAR Solutions (i.e. those featured in the SESAR Solutions Catalogue) covering a wide range of operating environments and addressing the integration of, for example, queue management solutions, coupling AMAN- and DMAN-related solutions, validated improvements to ATFCM (e.g. UDPP, AOP–NOP integration, U-space) in support of industrialisation and deployment. The target is to progress significantly towards TRL7.

2.3.5.4.2 *Topic HORIZON-SESAR-2022-DES-IR1-WA6-2: Industrial research and validation for Master Plan phase C air–ground integration and autonomy*

Expected outcomes

This topic covers the industrial research required to achieve TRL6 maturity level for the evolution of the air–ground communication infrastructure, supporting technologies and operational concepts, as expected in phase C of the European ATM Master Plan 2020. The topics will address in particular air–

ground integration needs that rely on direct interactions between air and ground automation (automation levels 2 and 3).

- **Environment.** 4D trajectory operations will reduce fuel-burn and overall emissions per flight.
- **Cost-efficiency.** Increased air–ground integration supports the introduction of higher levels of automation in ATM. The objective in phase C is to achieve automation level 3 for ATC platforms, such that there is high level of automation support for action execution but actions are always initiated by the human controller. The implementation of higher levels of automation, when adopted consistently, will contribute to operational harmonisation and eventually to the cost-efficiency of the ATM system.
- **Operational efficiency.** Advanced communication means and increased automation (reduced workload for ATCOs and flight crews / remote pilots) will contribute to increased operational efficiency.
- **Safety.** Increased automation enables human actors to be discharged from routine tasks and to focus on strategic tasks, including oversight of the safety of operations. Developments on the cockpit side reduce pilot workload and improve safety. Increased data-sharing will also foster the early detection of potential safety issues and their mitigation.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **TBO data-driven trajectory prediction and conflict resolution.** Achieve TRL6 for a common data-driven trajectory prediction and conflict detection/resolution multi-sector capability/service (i.e. for use in the medium term) based on AI and ML and enabling advanced separation support to be provided to controllers. Enhanced resolution support (e.g. what-ifs and resolution advisory tools and services) should be provided based on predictive conflict detection and associated monitoring features, including additional trajectory prediction improvements using the most relevant elements of ADS-C EPP and known constraints, and the application of ML and big data techniques *(PJ.18-W2-56)*.
- **Aircraft as an aeronautical/meteorological information sensor and consumer.** Improved understanding and prediction of weather conditions contributes to enhanced flight safety and efficiency. In addition to information from on-board sensors, pilots receive updates in various formats via datalink, including simple text messages, graphics and satellite images. These inputs cover different time frames, ranging from past observations to predictions for the next several hours. It falls to the pilot to organise and geo-reference these data and to build a mental picture as quickly as possible. SESAR is examining novel and robust ways to support intelligent data pre-processing, smart filtering and integration, both on the ground and on board the aircraft, for the two-way exchange of meteorological data. Moving to SWIM-based technology will enable standardised exchange of information. One aspect of this solution is the definition and design of purple profile SWIM services for meteorological data, which so far has no specification. EUROCONTROL has published specifications only for the yellow profile to date. The research will contribute to the work of EUROCAE Working Group 76 and RTCA Special Committee 206 on meteorological datalink standardisation, and ICAO is also

developing standards for turbulence and space weather data, which could be downlinked or uplinked via a SWIM purple profile service. Downlink and uplink of data on weather (pressure, temperature, wind speed and direction), turbulence, space weather and icing considerations, and contrail-related information (e.g. air humidity), should also be addressed. The objective is to complete TRL6 *(PJ.14-W2-110)*.

- **IFR RPAS integration in controlled Class A–C airspace.** Achieve TRL6 for full IFR RPAS integration by developing the technical capabilities of the remote pilot station and RPAS air vehicle and procedural means to allow IFR RPAS to comply with the same ATC instructions that are used for manned aviation. This also covers the development of new procedures and tools for handling IFR RPAS in a cooperative environment in full integration with manned aviation (e.g. contingency procedures, adaptation of flight-planning processes, ATC tools and procedures to account for RPAS specificities, consideration of RPAS in the assessment of complexity, and separation minima for RPAS). The scope includes both en-route and TMA operations, including take-off and landing, as well as the airport surface and also FMP/NM for DCB purposes *(PJ.13-W2-117)*.
- **ATM–U-space interface and supporting technologies.** Complete the U-space–ATM interface solutions, incorporating in particular the needs identified in the results emerging from SESAR U-space projects, with a view to achieving a consolidated definition of U2 services and completing the validation of the required interfaces with ATM, as well as securing a baseline for U3 services and supporting the delivery of the European Commission's drone strategy 2.0. Cooperation with ongoing EASA and European standardisation activities is essential. The activities in this element should also look beyond SESAR, including to other Horizon 2020 projects, EASA task forces, standardisation projects, EDA projects, state projects and ICAO developments, to enable the production of a detailed, up-to-date and accurate baseline from which regulation, standardisation, research and development can progress in a harmonised manner across Europe *(PJ.34)*.

2.3.5.4.3 Topic HORIZON-SESAR-2022-DES-IR1-WA6-3: Industrial research and validation for European Master Plan phase C capacity on demand and dynamic airspace

Expected outcomes

The key objective of this topic is to achieve TRL6 maturity level for solutions under phase C of the ATM Master Plan 2020 relating to capacity on demand and dynamic airspace management.

- **Capacity.** Capacity is increased through dynamic airspace management, responding with flexibility to airspace users' flight trajectory needs.
- **Safety.** Safety is improved through better anticipation and management of potential overload.
- **Efficiency.** Efficiency is increased thanks to monitoring of DCB measures and network performance, and the implementation of corrective actions.
- **Cost-efficiency.** Progress in this work area enables improved ATM resource planning and better use of existing capacities, leading to reduced ATC and airport capacity costs.
- **Predictability.** The provision of information regarding the planned network situation, taking into account all known constraints and time deviation, will be made possible by

anticipating demand–capacity imbalance and improving the implementation of DCB solutions.

- **Flexibility.** There will be a higher degree of common awareness among all stakeholders and greater access to opportunities to remedy the situation in the event of late changes in capacity or demand.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Increased flexibility in ATCO validations within an ATSU or between two ATSUs with similar consoles, tools and HMIs** (typically, but not necessarily, from the same ANSP). Standardisation of ATCO procedures and more generic en-route controller procedures can reduce the amount of training required for en-route or TMA controllers to be endorsed and/or to stay current in a sector or group of sectors, thanks to new tools and/or procedures. The objective is to allow more flexible rostering within a centre or across ATSUs from the same ANSP thanks to the virtual centre concept (assuming that the ATSUs use similar consoles and tools). This also includes the development of smart sector grouping options, so that controllers can remain validated for the same number of sectors as today, but the number of different sector groups is increased, in order to increase the flexibility of rostering processes. It also includes innovative concepts for currency requirements based on recording additional data compared with today (e.g. traffic types, traffic levels) so that not all hours on console count the same or the total number of hours required for currency remain the same but requirements on a sector are loosened (e.g. by counting hours in a neighbouring sector with a certain weighting). This concept may help controllers to accept delegation of airspace as outlined in the airspace architecture study and as per the virtual centre solution. The objective is to complete TRL6 *(PJ.10-W2-73 IFAV and PJ.33-W2-01)*.
- **Increased flexibility in ATCO validations through night-only validations within an ATSU or between two ATSUs with similar console tools and HMIs** (typically, but not necessarily, from the same ANSP). The validation of a controller to work in a sector at top capacity during the day requires detailed knowledge of airports, coordination procedures, traffic patterns and sector transfer conditions that are never applied during night shifts (because certain airports are closed, some sectors are always band-boxed and some traffic flows do not happen during the night). The objective of this activity is to develop a concept for night-only validation, aiming at reaching TRL6. This could, for example, be applied within a centre with multiple sector groups: a controller could be validated for day operations only for one sector group but could work nights in all sector groups, thus increasing flexibility in rostering. Another use case would be having a group of controllers specialising in night shifts only, and able to work in both their own ATSU and a second ATSU, thus allowing the two ATSUs to be consolidated during the night *(PJ.10-W2-73 IFAV and PJ.33-W2-01)*.
- **Collaborative management at regional airports.** The airport operations centre concept was originally designed for large airports during previous SESAR phases and further developed through the total airport management project, based on a platform/operational structure that collaboratively and proactively manages airport operations performance. Although regional airports do not generally experience operational constraints at the same scale as larger airports, they do experience issues that result in their operations underperforming. A lack of communication and

information shared among stakeholders can cause unforeseen deterioration in airport performance, with potential knock-on effects on the ATM network. This covers the development of a 'Lite' APOC, aimed at improving inbound, turnaround and outbound predictability based on an enhanced local collaborative environment and better connectivity with the ATM network. Airport and network information will thus be exchanged more reliably, resulting in improved situational awareness and supporting pre-tactical and tactical decision-making. The objective is to complete TRL6 *(PJ.04-W2-28.2)*.

- **Environmental performance management.** Management of airport operations often necessitates trade-offs between different performance criteria (flight delay, passenger satisfaction, resource availability, etc.). The objective is to reach TRL6 for solutions focused on environmental performance management, with the aim of integrating environmental considerations into the overall airport operations management process, bringing the issue of environmental performance into the decision-making process *(PJ.04-W2-29.3)*.

2.3.5.4.4 Topic HORIZON-SESAR-2022-DES-IR1-WA6-4: Industrial research and validation for the European Master Plan phase C civil–military interoperability and coordination

Expected outcomes

The key objective of this topic is to achieve TRL6 maturity level for civil–military objectives under phase C of the ATM Master Plan 2020, supporting higher levels of civil–military coordination and interoperability.

- **Environment.** Further integration of military flight data into flight planning and the network will allow civil airspace users to make better use of available airspace capacity, thus leading to greater fuel efficiency.
- **Capacity.** Improving how military airspace demands are managed will lead to a more efficient overall use of available airspace capacity by civil traffic.
- **Security.** The confidentiality, integrity and availability of information and data are crucial in ensuring safe and secure military operations.
- **Cost-efficiency.** The dual use of a service-driven integrated CNS infrastructure will ensure cross-domain CNS consistency in terms of robustness, spectrum use and interoperability for military and civil users. Integrated CNS services will ensure that military needs are met in terms of security, appropriate levels of quality of service and access to radio frequency spectrum resources, while reducing costs.
- **Civil–military coordination.** The coordination of shareable data relating to mission trajectories with the NM will ensure the optimal and timely integration of military flight data into the network, thus allowing solid and reliable traffic predictions.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Dynamic airspace configurations (levels 1 and 2).** Dynamic airspace configurations and airspace management will improve the use of airspace capacity for both civil and military users by increasing the granularity and flexibility of airspace organisation and design. The objective is to achieve TRL6 for a fully dynamic, agile and cross-border airspace management concept that will take into consideration all capacity/demand aspects and constraints in one seamless process, with a higher level of modularity and flexibility up to the execution phase, all supported by automated tools *(PJ.09-W2-44)*. This includes the following elements.

- The integration of dynamic airspace configurations with ATFCM into a single rolling planning process will collaboratively optimise traffic flows and airspace resource utilisation, thus increasing levels of capacity and flexibility to allow capacity variations in time and space to meet levels of demand.
- Digital INAP will optimise the flow management process by addressing the planning gap between ATFCM and ATC processes and will facilitate layered ATM planning in the execution phase, including the development of automation support (e.g. what-if and what-else tools based on AI, ML and big data).
- The research will investigate the integration of concepts and procedures to allow flexible sectorisation to be dynamically modified based on demand.
- DMA 2 will support the dynamic configuration of segregated airspace and management of mission trajectories, thus contributing to the efficiency of both civil and military operations. The areas will have the potential to 'roll up' following use over time, distance and volume as a mission progresses, allowing the early release of airspace for other users.

- **Improved and harmonised operational air traffic flight plan.** This improved flight plan will constitute the first description of the mission trajectory integrated into the ATM network systems for processing and distribution. Interaction between WOCs and the NM in terms of integrated operational air traffic flight plan management will be covered *(PJ.07-W2-40)*.
- **Integration of mission trajectories into network operations.** This will involve all the actors concerned (e.g. military airspace users / WOCs, the NM, ATS providers (civil or military) and military control / air defence units) to accommodate individual military airspace user needs and priorities without compromising optimum ATM system outcomes or the performance of any stakeholder. This will include integrating military demand into ATM network operations (Mission trajectory and ARES). Mission trajectories will be integrated into a TBO environment throughout all phases of trajectory planning and execution (SMT/RMT); they will be subject to trajectory management processes and include 4D targets and ATM constraints *(PJ.07-W2-40)*.

2.3.5.5 *Work Area 4: Fast-track innovation and uptake topic addressing U-space and urban air mobility*

Specific conditions for WA4	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 7.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 35.00 million.
Type of actions	Innovation action (IA)

Legal and financial set-up of the grant agreements	Grants awarded under this work area will have to submit the following deliverables: • contextual note • Safety and Performance Requirements & Interoperability Requirements in the context of the Operational Service and Environment Description (SPR-Interop/OSED) • Technical Specifications and Interface Requirements (TS/IRS) • Validation Plan (VALP) • Validation report (VALR) • Cost Benefit Analysis (CBA) • Standards needs (STAND) • Regulatory needs (REG) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated) Purchases of equipment, infrastructure or other assets specifically for the activities (or developed as part of the action tasks) may be declared as full capitalised costs.
Other requirements	The maximum project duration is 36 months.

2.3.5.5.1 Topic HORIZON-SESAR-2022-DES-IR1-WA4-1: Fast-track innovation and uptake for U-space and urban air mobility

Expected outcomes

U-space provides an unparalleled opportunity to experiment, test and validate some of the key architectural principles and technology enablers of the future digital European sky before incorporating them into the broader ATM ecosystem. It will accelerate the digital transformation of the European ATM system while opening the way to the safe integration of new vehicles into the airspace.

- **Environment.** U-space will not increase the environmental footprint of the air transport system. Specific metrics will be identified, tailored to the U-space environment and the types of vehicles operating within it (most of them are expected to be zero-emission aircraft). Special consideration should be given to the noise impact of low-level operations enabled by U-space. The growing use of zero-emission UAVs enabled by U-space may also contribute to reducing the environmental footprint of the overall transport system, for example by reducing road traffic levels.
- **Passenger experience.** In terms of passenger experience and overall socioeconomic contribution, U-space will enable and accelerate the drone economy, opening the way to new services (delivery, inspection, security, UAM, etc.) that will increase the well-being of European citizens. U-space will foster the development of a new high-tech

economic sector in Europe, leading to wealth and job creation. Particular attention must, however, be paid to safeguarding privacy and ensuring social acceptance.

- **Capacity.** U-space will not negatively affect the capacity of the ATM system and will create additional system capacity by enabling large volumes of unmanned aircraft to access the airspace. Specific capacity metrics are to be developed for U-space, covering safety and other concerns such as noise.
- **Cost-efficiency.** U-space will not negatively affect the cost of providing ATM services. Specific cost-efficiency metrics are to be developed for U-space, focusing on the cost of delivering U-space services.
- **Operational efficiency.** U-space will substantially reduce the costs of operating unmanned aircraft in the European airspace and will not negatively affect the operating costs of other airspace users. Specific operational efficiency metrics are to be defined for U-space, including fairness aspects.
- **Safety.** U-space will not negatively affect the safety of the ATM system. Specific safety metrics are to be defined for U-space.
- **Security.** U-space will not negatively affect the security of the ATM system. Cybersecurity will be a key area to be considered in relation to U-space, especially regarding interaction (data exchange) between U-space services and ATM systems.

This topic is designed to accelerate the development of high-risk, high-gain projects with a view to shortening the time to market for disruptive and highly innovative solutions. These activities may start at very low TRL levels but should aim to deliver as rapidly as possibly new products and services to the market at TRL7 (system demonstration in an operational environment).

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Enabling safe and autonomous operations in all types of airspace.** This involves the development of technological and operational enablers leading to the execution of meaningful demonstrations showcasing autonomous operations involving electric vertical take-off and landing (eVTOL) and large drones in all types of airspace (controlled, uncontrolled, suburban and urban areas). It also includes simulation to enable the analysis, design, testing and validation of the future U-space ecosystem (*R&I need: support the development of the U-space regulatory framework and required standards)*.
- **U-space advanced services (U3).** This will support more complex operations in dense areas and may include capacity management and assistance for conflict detection. New technologies, higher levels of automation and miniaturisation (including ML and AI, automated DAA functionalities and reliable means of communication) will enable a significant increase in operations in all environments and will reinforce interfaces with ATM/ATC and manned aviation. These advanced services should include, in particular, collaborative interface with ATC, strategic/tactical conflict resolution and dynamic capacity management. These services should build on U1/U2 capabilities but should also result in the development of new capabilities, such as connectivity (vehicle-to-vehicle and vehicle-to-infrastructure) and DAA *(R&I need: develop advanced U-space services)*.
- **U-space full services (U4).** In particular, services offering integrated interfaces with manned aviation are required, to support the full operational capability of U-space. They

will require very high levels of automation, connectivity and digitalisation, both for the drone and for the U-space system *(R&I need: develop advanced U-space services)*.

- **Legal and financial aspects of U-space at U3 and U4 level.** A detailed investigation is required of the legal and financial aspects of U3 and U4 U-space operations, including general and aviation law, and covering safety and security issues, liability issues, certification issues and U-space services financing models. This is a transversal activity, which will need input from the two previous addressed aspects – U3/4 services *(R&I need: financial and legal aspects)*.
- **U-space services above very-low-level airspace.** UAM covers all types of urban air operations that require the extension of U-space services beyond the very-low-level limit. Drone operators and UAM operations will require access to higher altitudes and areas close to commercial manned aviation (e.g. airports); at the same time, manned aircraft flying in or adjacent to very-low-level airspace could make use of U-space services. A safe and equitable integration of these operations with manned aviation will require additional U3–U4 services. The development of interoperability and a CDM process between urban airspace operations, ATM and city authorities will be key for future urban airspace operations *(R&I need: applications above very-low-level airspace and enabling UAM)*.
- **Enabling UAM.** The requirements of UAM operations are expected to be the most challenging for the U-space ecosystem. One of the key research questions is how to integrate autonomous operations over populated areas safely into complex and congested airspace environments, with operations involving vehicles interacting with U-space and conventional ATM services. The research should investigate how U-space can support the transition from piloted to autonomous operations. The evolution of U-space, together with its associated regulatory framework and standards, will need to be synchronised and coordinated with the development of the UAM concept of operations, future UAM services and the certification of UAM vehicles. Special consideration should be given to the operational limitations of these new vehicles and how U-space can contribute to operational safety by protecting their operation in contingency and non-nominal situations (*R&I need: enabling UAM)*.
- **U-space services for general aviation aircraft and rotorcraft.** General aviation aircraft and rotorcraft are expected to fly jointly with drones in some portions of airspace. In order to enable safe operations, U-space services will need to be provided to airspace users such as general aviation aircraft and rotorcraft users. The targeted services are based on enhanced information-sharing to enable improved situational awareness at both strategic and tactical levels *(R&I need: ATM–U-space integration)*.
- **Advanced airborne capabilities for air–ground integration.** This will involve developing the airborne technologies required to enable safe operations, advanced situational awareness and autonomous decision-making. Interoperable, performance-based CNS services in U-space need to be developed and validated in operational environments. Activities should focus on air–ground integration following a total-system approach. This includes airborne sensor technology for situational awareness and safety, trajectory management, DAA solutions for cooperative and non-cooperative traffic, and high-integrity data communication *(R&I need: CNS and separation minima)*.
- **Environmental sustainability and social acceptance.** Work is required to ensure that the new operations enabled by U-space and UAM are acceptable to the public. This

includes the identification and development of measures to reduce the environmental impact of U-space operations (noise, visual pollution and CO_2), ensuring adequate levels of safety and security. This work should consider as a starting point the findings of the 2021 EASA study on the social acceptance of UAM in Europe ([49]) *(R&I need: U-space social acceptance)*.

2.3.5.6 *Work Area 5: Fast-track innovation and uptake topics*

Specific conditions for WA5	
Expected EU contribution per project	The SESAR 3 JU estimates that a maximum EU contribution of EUR 5.00 million would allow these outcomes to be achieved. Nonetheless, this does not preclude the submission or the selection of a proposal requesting a different amount.
Indicative budget	The total indicative budget for this work area is EUR 22.00 million
Type of actions	Innovation action (IA)
Legal and financial set-up of the grant agreements	Grants awarded under this work area will have to submit the following deliverables: • contextual note • safety and performance requirements & interoperability requirements in the context of the operational service and environment description (SPR-Interop/OSED) • Technical specifications and interface requirements (TS/IRS) • Validation plan (VALP) • Validation report (VALR) • Cost benefit analysis (CBA) • Standards needs (STAND) • Regulatory needs (REG) • Data Management Plan (DMP) (to be submitted at the beginning, at mid-term and towards the end of the project) • plan for dissemination and exploitation including communication activities - CDE (to be submitted within 6 months after signature date and periodically updated) Purchases of equipment, infrastructure or other assets specifically for the activities (or developed as part of the action tasks) may be declared as full capitalised costs.
Other requirements	The maximum project duration is 36 months.

2.3.5.6.1 Topic HORIZON-SESAR-2022-DES-IR1-WA5-1: Fast-track innovation and uptake for capacity on demand and dynamic airspace

Expected outcomes

([49]) https://www.easa.europa.eu/sites/default/files/dfu/uam-full-report.pdf

The introduction of dynamicity in the management of airspace and the capacity-on-demand service will unlock performance benefits in the following areas.

- **Environment.** More precise trajectories for arrival and departure will make it possible to reduce noise impact.
- **Capacity.** Capacity is measured in terms of either ATFM delays (lack of capacity) or throughput. En-route capacity aims to maintain ATFM delays at 0.5 minutes per flight or less. TMA and peak runway throughput will be increased according to traffic forecasts. A more stable and predictable level of capacity will be achieved in all-weather operations. In addition, by providing capacity dynamically where and when it is needed and reconfiguring the airspace to match traffic flows, overall system resilience will be significantly increased.
- **Cost-efficiency.** Dynamic airspace configurations, capacity on demand and ATCO training programmes will provide scalability. ATCO productivity is expected to increase significantly.
- **Operational efficiency.** Trajectory management and dynamic airspace configurations will provide further improvements in vertical flight efficiency and cruising/taxiing fuel consumption when flights are subject to queueing. Overall improvements in capacity and trajectory management and use of dynamic airspace configurations are expected to reduce the average delay in block-to-block times by 4 minutes per flight.
- **Safety.** Safety levels will be maintained.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **On-demand ATS.** This will require the development of digital platforms and services leveraging state-of-the-art technologies to enable capacity on demand *(R&I need: on-demand ATSs)*. It will involve, for example:
  - a cloud-based, cybersecure digital platform for on-demand capacity management enabling all airspace users and all types of vehicles (traditional, hydrogen, electric, military) to access airspace in the context of dynamic airspace management, remote provision of air ATS and ATM–U-space convergence;
  - offering an increased level of capacity while accepting a much higher level of complexity so that optimised flight-efficient trajectories do not result in structural limitations on capacity;
  - offering increased levels of capacity and flexibility to allow capacity variations in time and space to meet levels of demand;
  - offering airspace users at all times the most environmentally friendly options when there is a need to constrain traffic, particularly when queueing aircraft at the arrival or departure runways, so that holding no longer exists as part of normal operations, and, if and when there is a need for conflict resolution, offering real-time options to airspace users so that they can select the least penalising trajectory;
  - enhanced network traffic prediction and shared complexity representation using data science techniques such as AI and ML to improve the quality of traffic forecasts and increase network stakeholders’ confidence in planning information;

  - use of ML to identify and exploit information patterns and AI to identify and design new elementary basic sector volumes for complexity detection and resolution, while balancing workloads and optimising resources.

- **ATM continuity of service despite disruption.** This element will require the development of digital platforms and services leveraging state-of-the-art technologies to enable ATM continuity of service despite disruption (e.g. during capacity bottlenecks, adverse weather, national system breakdowns or disruptive social actions) *(R&I need: ATM continuity of service despite disruption)*. This will involve, for example:

  - smart digital solutions for predicting adverse situations (in relation to weather, capacity, etc.) and distributed decision-making between involved stakeholders, minimising the risk and impact of disruption, and including facilitation of cross-border dynamic and remote ATS
  - improvements to airline operations based on the use of digital technologies (e.g. big data, ML algorithms, AI, IoT, behavioural economics, improved market modelling, complexity science) to support airline decision-making processes in disruption scenarios; the integration of airline operations into the network; collaboration between FOCs, the network management function and ATC; and better consideration of airspace user preferences in DCB and sequencing processes; etc.;
  - enriched DCB information and enhanced what-ifs available to improve AUs' decision-making processes when planning or replanning trajectories, encompassing information on DCB constraints/measures such as ATFCM regulations / CTOT / STAM and additional DCB information, for example on hotspots and congestion level indicators;
  - use of new data sources (big data), ML algorithms (including neural networks), AI-based decision support tools, behavioural economics, improved market modelling, complexity science, etc., to support network operations (e.g. models and methods for improving demand, flow and complexity forecasting and resolution);
  - use of big data and ML to identify best practices regarding regulation strategies for particular traffic-load patterns based on historical data and to develop optimised strategies for the most frequent traffic-load situations in the European ATFCM network;
  - use of modelling and operational data to understand typical resolutions to network planning and traffic management problems, with the aim of developing optimisation capabilities that are less human-centric.
  - use of new data sources (big data), ML algorithms, AI-based decision support tools, etc., to support airline decision-making in disruption scenarios in order to improve the resilience of the system.

- **Future data services and applications for airport and network.** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to enable future data services and applications for airports and the network *(R&I need: future data services and applications for airport and network)*. It will involve, for example:

  - an advanced user-driven prioritisation process, which provides airspace users with more control over the selection of flights that are delayed in order to prioritise them based on business needs, and which can gradually be extended to new ATFCM rules and queueing techniques;

- the integration of connectivity into the loop of ATM operations and the new datasets available through A-CDM, UDPP, AOP/NOP data, target time over/arrival and extended AMAN demand in order to further develop the rules for ATFCM and queuing priorities;
- enriched DCB information and enhanced what-ifs available to improve AUs' decision-making processes when planning or replanning trajectories, encompassing information on DCB constraints/measures such as ATFCM regulations / CTOT / STAM and additional DCB information, for example on hotspots and congestion level indicators.

2.3.5.6.2 *Topic HORIZON-SESAR-2022-DES-IR1-WA5-2: Fast-track innovation and uptake for virtualisation and cybersecure data-sharing*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Improved sectorisation will ensure more efficient flight routes and more optimal profiles and reduce delays at network level. At local level, requirements in respect of equipment and therefore power supply and cooling will be reduced.
- **Capacity.** Flexibility of sector-shifting to adapt to traffic demand and make best use of capacity at network level.
- **Cost-efficiency.** Potential reduction in infrastructure and the possible creation of competition between future data suppliers, which would reduce costs.
- **Safety.** Safety levels will be maintained, since virtualisation will have no impact on them.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Future data-sharing service delivery model.** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to enable future ATM data-sharing service delivery models *(R&I need: future data-sharing service delivery model)*. It includes for example, the following features.
  - A smart digital platform based on an EU-wide ATM data service layer will enable all ATM service providers to benefit from cross-border sharing of data. This would provide the data and specific applications (e.g. short-term conflict alerts, correlation) required for ATM services.
  - Delivery of advanced cloud-based services for applications such as flight correlation, trajectory prediction, conflict detection and resolution, arrival management planning, the provision of safety-net services (e.g. short-term conflict alerts, minimum safe altitude warnings, area proximity warnings) and decision-making support tools as a service. This could be considered in the context of the wider application of the 'free seating' and authentication concepts to cross-border delegation of ATS.

- **Infrastructure as a service:** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to enable a service-oriented approach to CNS infrastructure, with widespread implementation of IP-based technologies *(R&I need: infrastructure as a service)*. This includes, for example:
  - digital solutions enabling location-independent transmission of CNS data and/or voice communications with stronger reliance on satellite-based technologies, including integrated CNS applications using space-based sensors;
  - digital solutions for dynamic allocation of IP connections reducing the need for VHF channels on the ground side and the need for the airborne side to switch frequencies several times during the flight.
- **Free flow of data among trusted users across borders.** This element will involve the development of digital platforms and services leveraging state-of-the-art technologies to enable the sharing of data through interoperable platforms and the exchange of open data between trusted partners, combined with open architecture policies *(R&I need: free flow of data among trusted users across borders)*.
- **Cyber-resilience.** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to enable the protection of information and information systems, manage cyber-resilience risks and implement appropriate safeguards to ensure the delivery of services. In this context, it is necessary to apply best practices and specific techniques already established in other domains such as banking (e.g. system design principles, cryptography, blockchain, software-defined networking) *(R&I need: cyber-resilience)*. It will include, for example, the following features.
  - **Digital solutions for cyber-resilience.** The aim is to prevent a cyberattack from being successful, to prevent operational disruptions caused by successful cyberattacks, to prepare for and adapt to changing conditions due to successful cyberattacks, and to respond to and recover rapidly from successful cyberattacks to ensure the continuity of operational services at an acceptable performance level.
  - **Digital solutions to increase system robustness against cyberattacks.** The first and most impactful step towards strengthened cyber-resilience is to be able to keep operating in the event of a cyberattack by preventing cyberattacks from being successful. Elements that need to be addressed include increased foresight (prediction, anticipation, cyberintelligence), the introduction of patch management into safety-critical systems and the strengthening of controls related to intrusion prevention and detection. The research will cover both new technical cybercontrols in new and existing technical systems and improved human cyberskills in the operational context.
  - **Digital solutions for fast and effective cyberattack systems response.** When under attack from outside or even inside, the response to the attack is of the greatest importance. Responsive measures include restriction of services and initiation of pre-defined and trained sequences. The focus should be on the secure delivery of services and data while being aware of the attack in progress. Security by design is key in this context and includes alternate paths for critical processes, graceful degradation of critical systems, and independent functional duplication for critical processes, with clear separation between system functions. In addition, it is essential to provide methods and means to allow the solution to recover as quickly as possible from degraded modes (minimum recovery time).

- **Digital solutions for multistakeholder cybercontingency.** Being resilient requires an anticipated and pre-defined acceptable drop in performance in response to an attack, in order to absorb the energy of the attack. Several levels of degraded mode need to be anticipated and integrated into contingency plans, to ensure a continuously controlled operation while healing measures and repair works can be undertaken. This degraded mode needs to be maintained until the effects of the attack have been assessed and accounted for. With the increased connectivity in aviation, contingency management is increasingly becoming a multistakeholder exercise that requires extended situational cyberawareness that goes beyond the borders of individual organisations. A better understanding of attack impact and potential attack propagation scenarios through multistakeholder system dependencies is needed.

2.3.5.6.3 *Topic HORIZON-SESAR-2022-DES-IR1-WA5-3: Fast-track innovation and uptake for multimodality and passenger experience*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** Optimised operations due to improved gate-to-gate planning contribute to the optimisation of fuel-burn and therefore to reduced CO_2 emissions per flight. Additional environmental benefits will come from alleviating congestion at and around airports by improving passenger flows (through predictability and single ticketing), from supporting access to / egress from airports using environmentally friendly means and from integrating vertiports for electric UAM vehicles.
- **Passenger experience.** Optimised operations due to improved gate-to-gate planning contribute to the optimisation of fuel-burn and therefore to reduced CO_2 emissions per flight. Additional environmental benefits will come from alleviating congestion at and around airports by improving passenger flows (through predictability and single ticketing), from supportingencouraging access to /egress from airports using environmentally friendly means and from integrating vertiports for electric UAM vehicles.
- **Capacity.** Fully integrating the most congested airports into the ATM planning process, introducing tools that allow user-driven prioritisation based on real-time multimodal passenger constraint information, monitored and shared accurately at network level, will help reduce departure delay, while improving IFR movement numbers at these airports and ultimately IFR network throughput.
- **Cost-efficiency.** The data-sharing-powered network performance cockpit will enable increased predictability of traffic flows coupled with increased network flexibility and resilience. This in turn will help reduce en-route congestion and ANS costs. New data-sharing standards and systems will allow new ‘as a service’ businesses, creating more value for aviation, within an integrated transport system.
- **Operational efficiency.** Improved, accurate, customer-focused planning, including user-driven prioritisation, allows operators to customise and optimise every flight, balancing their individual constraints against those of the network, with a direct positive impact on additional gate-to-gate flight time, fuel-burn per flight, and operational costs from congestion and disruption. There will also be a positive impact on resilience thanks to

data-sharing, increased knowledge and integrated network crisis management processes.

- **Safety.** Better integration of UAS, UAM and general aviation operations at airports and within TMAs will directly contribute to increased, seamless and hassle-free mobility while enhancing operational safety. Similarly, punctual, predictable, integrated ground transport to/from the airport will reduce passenger stress and contribute to reducing stress-related accidents.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Access to / exit from the airport.** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to enable a better door-to-door experience for passengers. Considering ATM as an integrated part of an intermodal transport system, this about sharing data between modes and collaborating better to optimise the performance of the overall transport system *(R&I need: access to / exit from the airport: airports are obvious multimodal nodes for aviation and SWIM)*. It includes for example, the following features.
  - **Real-time information exchange.** This will give stakeholders (including mobility providers) an increased knowledge of the entire multimodal journey, which will enhance the reliability of multimodal journey planning, identifying potential access issues that could affect the punctuality of operations, alleviating congestion, mitigating regulatory constraints, etc.
  - **Improved planning and cooperation.** This will involve extended integration of ATM network planning (multi-slot swapping, aircraft operator-driven prioritisation processes etc.) and cooperation on enhanced collaborative airport performance planning and monitoring, enabling passengers to have a full picture of their journey and optimising their door-to-door time.
  - **Extended CDM process.** This will encompass specific stakeholder information requirements relating to elements of the multimodal journey, to be fully included in the AOP and NOP collaborative processes.
  - **Use of AI.** This will help optimise pre-screening of passengers and departure/arrival queues/sequences in order to optimise door-to-door journeys.
  - **Integration of vertiports.** Vertiports will be a crucial enabler for UAM, providing a safe and secure area for air taxi operators and people using air taxis. Their integration into airport operations and city-surface transport networks faces design, organisational, operational and safety challenges that need to be investigated and validated to facilitate operational implementation in a European city before 2027.
- **Passenger experience at the airport.** This refers to the development of digital platforms and services leveraging state-of-the-art technologies to improve the passenger experience inside the airport *(R&I need: passenger experience at the airport)*. It will includes, for example, the following features.
  - **ATM data-sharing for a seamless door-to-door passenger journey.** This includes in particular the development of open application programming interfaces to share ATM data (e.g. updated flight departure/arrival data) with public transport systems and the

demonstration of their value to passengers in terms of improving their door-to-door experience.

- **Digitalisation of passenger processes at the airport.** This element includes the introduction of digital passenger processes at the airport for a seamless passenger experience and improved predictability of turnaround processes by reducing the uncertainty originated by current passenger processes. The scope may include digitalisation of security checks (e.g. video analytics with full and/or behavioural biometrics, walk-through body scanners, AI-powered queue management, facial recognition), digital border control (e.g. advanced automation processes integrated with check-in and security processes such as biometric pre-authentication), biometric support for a better and more predictable boarding process and development of mobile applications to support passenger travel to/from the airport and wayfinding at the airport to avoid late arrival or no-show at the gate.
- **Improved integration of landside and airside processes.** Inclusion outputs from landside processes (passenger and baggage) to be used to improve the accuracy and predictability of airside operations.
- **Business intelligence and ML.** These will be used to help airport stakeholders collaborate to align process and resource capacity with predicted demand to reduce queues.
- **Optimised intra-airport flow.** This will reduce queuing for airport services and reduce walking distance for passengers, for fast and efficient boarding and disembarkation.
- **Improved mobility planning and common situational awareness.** Smart airports, with landside and groundside fully integrated into the ATM network, will be based around connectivity and other technologies to improve operations and the user experience. This will include the integration of airport network planning and the timely exchange of surface network, airport and ATM network information.

- **An integrated transport network crisis management process.** This element will involve the development of digital platforms and services leveraging state-of-the-art technologies to enable coordination – when managing a crisis – between different modes of transport and a multitude of actors, including representatives of local and national authorities. The research should also include proposals for counter-measures based on the timely acquisition and sharing of information, and it should consider a broad set of threats affecting, directly or indirectly, aviation. A non-exhaustive list of threats would include volcanic ash dispersions, armed conflict, hazardous chemical events, spread of diseases / pandemic, earthquakes, flooding, major failure of a pan-European function and (massive) cyberattack *(R&I need: an integrated transport network crisis management process)*.

2.3.5.6.4 *Topic HORIZON-SESAR-2022-DES-IR1-WA5-4: Fast-track innovation and uptake for AI for aviation*

Expected outcomes

Project results are expected to contribute to the following expected outcomes.

- **Environment.** AI will enable the optimisation of aircraft trajectories, potentially reducing the aviation environmental footprint.
- **Capacity.** AI will play a fundamental role in aviation/ATM to address airspace capacity shortages, enabling dynamic configuration of the airspace and allowing dynamic spacing separation between aircraft.
- **Cost-efficiency.** AI will enrich aviation datasets with new types of datasets, unlocking air–ground cooperation using AI-based applications, fostering data-sharing and building up an inclusive AI aviation–ATM partnership. This will support decision-makers, pilots, ATCOs and other stakeholders, bringing benefits in cost-efficiency by increasing ATCO productivity (reducing workload and increasing complexity capabilities).
- **Operational efficiency.** Increasing predictability will be a key function of AI, as it will enable traffic predictions and forecasts that will boost punctuality.
- **Safety.** Safety science will also need to evolve to cope with the safety challenges posed by the introduction of ML. Current safety levels will be at least maintained using this technology.
- **Security.** AI will make it possible to stay cyber-resilient in the face of new technologies and threats; the objective is to maintain a high level of security.

Scope

To achieve the expected outcomes, all or some of the following should be addressed.

- **Trustworthy AI-powered ATM environment.** This refers to the the development of advanced AI applications (e.g. supporting automation level 4) for ground or airborne use, with a particular focus on the demonstration of new methodologies for the validation and certification of advanced AI applications that will ensure their transparency, robustness and stability under all conditions. It includes aspects such as explainability, learning assurance, formal methods, testing, licensing, in-service experience and online learning assurance *(R&I need: trustworthy AI-powered ATM environment)*.
- **AI for prescriptive aviation.** This refers to the development of digital solutions and services leveraging state-of-the-art technologies to demonstrate how AI can be used in a highly automated and safety-critical environment to deliver substantial and verifiable performance benefits while at the same time fully addressing safety concerns and using human skills. It also includes, for example, abnormal situation management. AI/ML have great potential for predictions/forecasts under normal circumstances, but further evolution will be needed if they are to be used in the management of abnormal situations: a prescriptive approach will be required to monitor reality and specify precursors indicating possible deviations from what is expected. This covers the exploitation of aviation data hubs. Developments in this area might include, for example, solutions for the detection of abnormal situations and aircraft behaviour (i.e. deviations from what is expected); ML, big data and predictive analysis techniques will make it possible to analyse situations, predict potential aircraft trajectories and detect suspicious aircraft *(R&I need: AI for prescriptive aviation)*
- **Human–AI collaboration.** This element will involve the development of digital solutions leveraging state-of-the-art technologies to support aviation actors in a highly automated environment (automation level 4) while ensuring that humans understand what the

systems are doing and maintain the right level of situational awareness *(R&I need: human–AI collaboration: digital assistants)*. It includes for example,:

- advanced AI applications for airlines, ANSPs and airport managers in a range of areas such as fleet management, infrastructure monitoring, sectorisation and staff planning;
- advanced AI applications for regulators, with new safety and security indicators that support the (early) detection and predictions of new risks;
- new HMIs for ATCOs (e.g. augmented reality) and the capability to monitor ATCO workload in real time based on AI, as well as new skills and new training methods to support these new joint human–machine systems.

2.4 Call HORIZON-ER-JU-2023-FA1-SESAR (EU-RAIL – SESAR Synergy call)

In accordance with the SBA (recitals 10 and 12 and Article 5(2) c)), to achieve maximum impact, the joint undertakings should develop close synergies with other Horizon Europe initiatives and other Union programmes and funding instruments, particularly with those supporting the deployment of innovative solutions. Following the identification of synergies between them, joint undertakings should aim to determine budget shares, which should be used for complementary or joint activities between joint undertakings, in particular by dedicating, where appropriate, a part of the joint undertaking's budget to joint calls.

Under this basis, the EU-Rail and SESAR 3 Joint Undertakings will launch a joint call "Integrated air and rail network backbone for a sustainable and energy-efficient multimodal transport system" for a total of EUR 5 000 000 of co-funding and EUR 7 143 000 of total costs at 70% funding rate, with a fairly shared contribution between SESAR and EU-Rail (approximately 2 500 000 per JU). The modalities of this transfer will be detailed in an arrangement between both organisations.

The selection criteria and the call conditions can be found in the EU-Rail Work Programme "Europe's Rail Work Programme 2023-2024[50]".

2.4.1 Scope of the call

Aviation and railway are integral parts of the intermodal transport ecosystem expected to optimise door-to-door (D2D) mobility for people, and ultimately to meet citizens' expectations for increasingly seamless mobility, where they can rely on the predictability of every planned door-to-door journey and can choose how to optimise it (shortest travel time, least cost, minimal environmental impact, etc.).

To successfully address the expected outcomes, and improve the attractiveness of combined air-rail travel for passengers, in a door-to-door context, the following research elements shall be delivered:

- **Benchmark on existing solutions** of integrated rail and air traffic;
- **Integration of aviation and railway transport modes.** Development of tools, digital platforms and services for a better integration of aviation and railway transport modes, as part of an intermodal transport ecosystem expected to optimise multimodal mobility. This shall include:
  - Definition of single, common and collaboratively-agreed intermodal (airport / railway) operations plan. The objective is to deliver a shared airport/railway operations plan including agreed performance indicators and objectives e.g. punctuality, and building on information from different players and stakeholders from the two modes of transportation. The connection to the Network Operations Plan (NOP) is expected to be done via the (Airport Operations Plan) AOP (airport part of the intermodality plan). The intermodal operation may include optimised timetables, luggage handling and passenger information, etc.;
  - Definition of the interface between the air traffic management systems (ATMS) (in particular regarding airport-rail connection) and the rail traffic management systems (TMS), both for planning purposes and operations, including disruptions;

[50] Europe's Rail Work Programme 2023-2024: https://rail-research.europa.eu/about-europes-rail/europes-rail-reference-documents/europes-rail-annual-work-plan-and-budget/

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- Real-time information exchange services between aviation and railway giving stakeholders (including mobility providers) an increased knowledge of the multimodal journey and mobility providers the means to adapt and optimise traffic offers in the short term. This includes the elaboration of rationalised data-driven ATM/railway dashboards enabling stakeholders to have an up to date picture of the actual situation in both transport modes. These dashboards could be fed with key performance aviation and train indicators covering inter-modal management processes. These dashboards could also include predictive functionalities enabling stakeholders to proactively identify demand and capacity imbalances (location, duration, criticality, etc.), deviations compared to the shared plan, etc. This will enhance the reliability of multimodal journey planning, identifying as soon as possible potential access issues that could affect the punctuality of operations, and trigger the need for potential coordinated actions for alleviating congestion, mitigating regulatory constraints, optimising process, passengers journey management, etc.
- ATM-airport-railway collaborative decision making process. This enables collaborative decision-making involving both air transport and railway transport stakeholders with the aim of facilitating a more efficient strategic and tactical planning and management of intermodal operations, passenger flows and enhancing passenger experience between the two modes of transportation. This research element covers:
  - The evolution of ATM related concepts developed within ATM boundaries e.g. airport operations plan (AOP), airport operations centre (APOC), airport collaborative decision making (A-CDM), total airport management (TAM), network operations plan (NOP), etc.;
  - The integration of data from aviation and railway transport information systems;
  - The development of an integrated capacity management process to ensure modal shift from feeder flights to railway;
  - The development of visualisation and decision support tools to allow the involved stakeholders to perform “what-if”, “what-else” analyses and assess the impact of different decisions / scenarios in order to determine the optimal course of action (this could make use of artificial intelligence and machine learning techniques).

Research may also address:

- Post-operations analysis capabilities to allow both air and railway transport stakeholders to better plan operations and resources in the future aiming at a continuous improvement of intermodal operations;
- Use of AI/ML to support the optimisation of the ATM-rail multimodal interface developing smart digital solutions to streamline the management of multimodal air-rail transport flows (e.g. AI/ML-powered demand-driven predictions of flights, trains, passengers and departure/arrival queues/sequences for improving operations efficiency and for service offer across air-rail modes accommodating as much door-to-door journeys as possible, etc.);
- Business intelligence and machine learning to help intermodal stakeholders collaboration to align process and resource capacity with predicted demand to reduce queues.

(R&I need: An integrated transport network performance cockpit (from ATM SRIA))

- **An integrated aviation-railway transport network disruption and crisis management process.** Enable the coordination – when managing disruption and crisis – between air and railway transport modes and a multitude of actors, including local and national authorities' representatives. Research shall address the definition of the required data exchange for a situation of disruptions and crisis. The research should also lead to proposals for mitigation measures based on the timely acquisition and sharing of information, as well as it should consider a broad set of threats affecting, directly or indirectly, the intermodal system e.g. terrorism, volcanic ash dispersions, hazardous chemicals events, spread of diseases/pandemic, earthquakes, flooding, major failure of a pan-European function, (massive) cyberattack, etc. The proposal may include simulation scenarios to validate applicable use cases e.g. airport closure, rail strike, etc. *(R&I needs: an integrated transport network crisis management process (from ATM SRIA) and incident and disruption management (from Rail strategic SRIA)*

Additionally, the project to be funded under this topic shall:

- Target maturity level is TRL6 and validation activities should be defined accordingly. In particular, activities including system, subsystems model/prototypes in a relevant end-to-end environment.
- Propose a concept of operations (ConOPs) and high-level architecture of the proposed solution(s), further detail them into operational scenarios / use cases, leading to the definition and validation of requirements/specifications for data exchange, also in real-time, related to available capacity, disruptions, etc., and consequent respective airport operations - ATM – rail networks integration. Include a CBA for the proposed solutions ;
- Consider the following potential scenarios:
  - City pairs from different EU Member States, which have both airports and high-speed train connections;
  - International airport hub connected to a high-speed railway station. This scenario may also consider other transport modes serving and/or connecting both the airport and railway station if applicable e.g. local / regional train operators, local bus lines, trams, metros, taxis etc.;
  - Regional rail line serving a smaller (regional) airport. This may also consider as well other transport modes.
- Consider standards whenever possible, especially important with data sharing, integration of different transport modes, combination of ATMS and TMS and creation of new tools;
- Take into consideration the following reference material:
  - The interfaces definition should consider:
    - From SESAR: European ATM Architecture (EATMA)[51] and the relevant links to elements in the ATM architecture (e.g. capabilities, systems);
    - From EU-Rail: Conceptual Data Model (CDM)[52], the work done within Shift2Rail TD2.9 [53]on TMS.

[51] https://www.eatmportal.eu/working/signin
[52] https://projects.shift2rail.org/s2r_ipx_n.aspx?p=LINX4RAIL
[53] https://projects.shift2rail.org/s2r_ip_TD_r.aspx?ip=2&td=a86b26b5-2680-4765-9bc6-c935804d6aa6

  - The EU Data Strategy which aims to create a Common European Mobility Data Space[54]. Please consider also the existing work of EU-Rail (Flagship Project 1 – MOTIONAL[55], Federated Data Spaces) for building a trusted, reliable, cybersecure federated data space for the rail ecosystem - the Rail Data Space. The Rail Data Space provides exchange and sharing of digital resources across Rail operators, Infrastructure Managers and Suppliers as a component in the creation of a Common European Mobility Data Space. It is compliant with the principles of the European Strategy for Data, e.g., Data Sovereignty, Data level playing field, public-private Governance and Decentralized soft infrastructure. Furthermore, it is interoperable with other sectorial data spaces;
  - State-of-the-art documentation on existing solutions on integrated rail and air traffic.
- Involve relevant stakeholders from at least two EU Member States:
  - From the air sector perspective the proposals should foresee participation of, at least, airspace users (AUs) and airport operators;
  - From the rail sector perspective the proposals should foresee participation of, at least, High speed train operators, infrastructure managers and TMS operators, as well as regional/capillary line operators and TMS operators;
  - Research may include (if required) other stakeholders e.g. urban transport operators (metro, bus, etc.);
  - The inclusion of other modes of transport (e.g., UAM, cooperative, connected and automated mobility (CCAM), etc.) will be considered advantageous, in order to provide a full door-to-door experience validation.
- Take into consideration the existing work developed within SESAR and EU-Rail (especially IP4 projects[56], Flagship Project 1) in terms of state-of-the-art of existing solutions, tools, algorithms and approaches (e.g. passenger flow, predictions and traffic modelling, total airport management concept, etc.);
- Address data confidentiality e.g. GDPR aspects, as well as the approach on data sharing (including dataspaces tackled within EU-Rail project FP1-MOTIONAL).
- Address (cyber)security and safety aspects of the proposed architecture in close collaboration with the System Pillar. Also, the availability and integration of external services able to supply data and information to the air and rail network management systems to improve air-rail intermodality shall be investigated
- Target a balanced participation of entities from both the rail and aviation sector. The contribution brought by those entities is also expected to be insofar as possible balanced between the rail and aviation stakeholders. The applicants can justify a different approach for the correct implementation of the action.

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[54] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13566-Transport-data-creating-a-common-European-mobility-data-space-communication-_en

[55] https://projects.rail-research.europa.eu/eurail-fp1/

[56] https://projects.shift2rail.org/s2r_ip.aspx?ip=4

2.4.2 Expected outcomes

Project results are expected to contribute to the following outcomes:

- **Operational efficiency:** improved predictability and punctuality for journeys involving both air and railway modes of transport, thanks to a better overall planning and monitoring of operations;
- **Capacity:** a better integration of air and railway modes of transport will enable a better use of existing and future capacity e.g. by monitoring multimodal passenger flows information (e.g., status, demand, delays, etc.), share it to relevant stakeholders in air and railway modes e.g., transport service operators (TSPs) to take mitigation actions to help reducing potential delays;
- **Resilience:** improved resilience in case of disruption in either railway or air transport modes, or both will contribute to improve the passenger experience;
- **Environment**: optimised operations in rail and air transport due to improved intermodal planning, contributing to the optimisation of fuel-burn and therefore reductions of CO_2 emissions per journey. Additional environmental benefits (i.e. emissions, noise and/or local air quality) will come from alleviating congestion at and around airports / railway stations by improving passenger flows (through multimodal decision making, etc.), from helping access/egress to/from airports / railway stations via environmentally-friendly means, etc.;
- **Passenger experience**: optimised and seamless passenger experience by reducing the inefficiencies and friction points and overall travel time and transfer time between air-rail modes;
- **Cost-efficiency:** the data-sharing-powered applications between air and railway modes of transport will enable increased predictability of traffic flows coupled with increased intermodal network flexibility and resilience. This would in turn help reduce congestion and costs.

2.5 Call CEF-T-2021-SIMOBGEN

2.5.1 Background

Call CEF-T-2021-SIMOBGEN ([57]) is issued under the Connecting Europe Facility MAWP 2021–2027 for the transport sector. The programme has the general objective of building, developing, modernising and completing the trans-European networks, taking into account the EU's long-term decarbonisation commitments, and thus contributing to smart, sustainable and inclusive growth and to enhancing territorial, social and economic cohesion. It will contribute to the development of projects of common interest relating to efficient, interconnected and multimodal networks and infrastructure for sustainable, smart, interoperable, inclusive, accessible, resilient, safe and secure mobility. It will contribute to achieving a more sustainable modal composition of the transport system, in order to meet EU climate neutrality and zero-pollution ambitions by 2050.

The CEF contributes to the EU goals of climate-related spending and decarbonising transport. In accordance with the European Green Deal, CEF 2021–2027 will target a contribution of 60 % of its overall financial envelope to co-financing actions supporting climate objectives and moving fast

([57]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/cef-t-2021-simobgen-ertms-units towards zero-emission mobility. A methodology to track climate expenditures against the targets set has been developed by the European Commission and will be applied to all actions under the CEF.

The implementation of the MAWP aims to contribute to the completion of the Trans-European Networks – Transport project, thus further enhancing sustainable and smart mobility. It is expected that the support granted on the basis of the MAWP will contribute to the timely and efficient development of the Trans-European Networks – Transport Core Network, support the realisation of a robust and resource-efficient European transport system and address climate change in accordance with the European Green Deal.

The support granted will directly contribute to, *inter alia*, the achievement of important transport policy objectives such as establishing major interoperable transport axes interconnecting national networks and facilitating the functioning of the internal market; the optimal use of existing infrastructure capacities; improving the safety and reliability of the network; fostering cohesion and cross-border mobility; enhancing the accessibility of peripheral areas of the EU; enhancing an integrated multimodal approach aimed at shifting a considerable part of the transport that currently takes place by road to more sustainable modes of transport; increasing the capacity and performance of rail, inland waterways and short sea shipping infrastructure, thus contributing to a more balanced modal distribution; and reducing the negative environmental impacts of transport, in particular as regards greenhouse gas emissions.

The Digital Sky Demonstrators under this call contribute to two SRIA R&I flagships, namely U-space and UAM and the aviation Green Deal.

- **U-space and UAM.** Over the next 10 years, the implementation of this SRIA aims to unlock the potential of the drone economy and enable UAM on a large scale. To that end, a new ATM concept for low-altitude operations needs to be put in place to cater safely for the unprecedented complexity and high volume of the operations that are expected. This concept, referred to as U-space, will include new digital services and operational procedures and its development has already started under the SESAR 2020 programme. U-space is expected to provide the means to manage safely and efficiently high-density traffic at low altitudes involving heterogeneous vehicles (small UAVs, eVTOL vehicles and conventional manned aircraft), including operations over populated areas and within controlled airspace. U-space will have to integrate seamlessly with the ATM system to ensure safe and fair access to airspace for all airspace users, including UAM flights departing from airports.
- **Aviation Green Deal.** The objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, requires an acceleration in the shift to smarter and more sustainable mobility. This implies a need for aviation to intensify its efforts to reduce emissions. To this end, a set of operational measures to improve the fuel efficiency of flights will have to be put in place with the aim of enabling aircraft to fly their optimum fuel-efficient 4D trajectories. At the same time, to ensure sustainable air traffic growth, it is necessary to speed up the modernisation of the air infrastructure to offer more capability and capacity, making it more resilient to future traffic demand and more adaptable through more flexible ATM procedures. Furthermore, reducing aircraft noise impacts and improving air quality around airports will remain priorities.

2.5.2 Indicative budget

The indicative budget for this call is EUR 60 million. This call for proposals is managed by CINEA with technical assistance from the SESAR 3 JU.

Project budgets (maximum grant amount) for SESAR-related actions are expected to be around EUR 7 million per project (for projects submitted under CEF-T-2021-SIMOBCOEN-SESAR-DSDU-WORKS) or EUR 15 million per project (for projects submitted under CEF-T-2021-SIMOBCOEN-SESAR-DSDA-WORKS).

2.5.3 Objectives and themes addressed by the projects

2.5.3.1 *CEF-T-2021-SIMOBGEN-SESAR-DSDU-WORKS: Digital Sky Demonstrators on U-space and urban air mobility*

Objective

The Digital Sky Demonstrators on U-space, supported by the new regulatory framework and a set of new standards, will support the implementation of U1/U2 services across Europe, ensuring safety and interoperability. U-space will have to integrate seamlessly with the ATM system to ensure safe and fair access to airspace for all airspace users.

U-space is expected to have a profound socioeconomic impact, creating a new marketplace for U-space service provision and accelerating the advent of the drone and UAM economy. The objective of the Digital Sky Demonstrators is to accelerate the transition towards deployment of a number of U-space services and capabilities:

- **Environment.** U-space will not increase the environmental footprint of the air transport system. Specific metrics will be identified, tailored to the U-space environment and the types of vehicles operating within it (most of them are expected to be zero-emission aircraft). Special consideration should be given to the noise impact of low-level operations enabled by U-space. The growing use of zero-emission UAVs enabled by U-space may also contribute to reducing the environmental footprint of the overall transport system, for example by reducing road traffic levels.
- **Passenger experience.** In terms of passenger experience and overall socioeconomic contribution, U-space will enable and accelerate the drone economy, opening the way to new services (delivery, inspection, security, UAM, etc.) that will increase the well-being of European citizens. U-space will foster the development of a new high-tech economic sector in Europe, leading to wealth and job creation. Particular attention must, however, be paid to safeguarding privacy and ensuring social acceptance.
- **Capacity.** U-space will not negatively affect the capacity of the ATM system and will create additional system capacity by enabling large volumes of unmanned aircraft to access the airspace. Specific capacity metrics are to be defined for U-space, covering safety and other concerns such as noise.
- **Cost-efficiency.** U-space will not negatively affect the cost of providing ATM services. Specific cost-efficiency metrics are to be defined for U-space, focusing on the cost of delivering U-space services.
- **Operational efficiency.** U-space will substantially reduce the costs of operating unmanned aircraft in the European airspace and will not negatively affect the operating

costs of other airspace users. Specific operational efficiency metrics are to be defined for U-space, including fairness aspects.

- **Safety.** U-space will not negatively affect the safety of the ATM system. Specific safety metrics are to be defined for U-space,
- **Security.** U-space will not negatively affect the security of the ATM system. Cybersecurity will be a key area to be considered in relation to U-space, especially regarding interaction (data exchange) between U-space services and ATM systems.

Themes and priorities

To achieve the expected outcomes, all or some of the following should be addressed.

- **Market uptake of U1 and U2 U-space services.** U1 includes services such as registration, remote identification and geofencing; U2 encompasses services such as flight planning, flight approval, tracking and the basic interface with conventional ATC. This element includes the final establishment of the safety and performance requirements for U1 and U2 services, based on their demonstration and pilot implementation in an integrated environment, and covering nominal and contingency situations. The objective is to ensure that requirements are coordinated across Europe and that early movers are incentivised, in order to accelerate uptake. The research will also addresses the following elements.
    - **U1 and U2 U-space services architecture, cross-border interoperability and standardisation.** This includes close coordination with ICAO and EASA to ensure global interoperability. It also includes full mechanisms for interoperability with manned aviation (ATC and other AUs), as well as contingencies. In these activities, the focus is on the definition of the services and the interoperability requirements in support of an open architecture, rather than the requirements for the services themselves. The outputs will contribute to the standardisation of U-space services.
    - **Multiple basic U-space services.** Although descriptions of many services exist at U1 and U2 levels, different U-space architecture options still need to be further developed to ensure that the full range of requirements can be met by the different types of operations and to guarantee safe and secure interoperability. In particular, one of the challenges is to enable the simultaneous operation of multiple U-space service providers in the same airspace *(R&I need: mature basic U-space services)*.
    - **Legal and financial aspects of U-space at U1 and U2 level.** This refers to the legal and financial aspects of U1 and U2 U-space operations, including general and aviation law, and covering safety and security issues, liability issues, certification issues and U-space services financing models. This is a transversal activity, which will need input from the two previous research elements.
    - **Support for deployment and regulation.** This covers integrated demonstrations of U-space services, potentially starting with demonstration in a controlled environment (U-space test centres) and then moving on to the real environment.
- **Demonstration of U-space/ATC interoperability.** Building on the previous validation activities, this element covers the demonstration of the advanced U-space/ATC interoperability concept, including in particular demonstration of simultaneous and safe provision of ATC and U-space services in the same airspace. This could also cover the

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transfer of U-space operational concepts or technologies to ATM or the transfer of ATM concepts or technologies to U-space.

- **Demonstration of U-space for UAM.** UAM refers to the provision of mobility services in an urban environment using air vehicles, which encompass everything from manned helicopters, as currently flown, through small inspection and delivery drones to 'flying taxis', with or without a pilot. The demonstrations will aim to showcase solutions that contribute to safely integrating UAM with manned aviation and ATC, defining new operational concepts (underpinned by existing and new technologies) while contributing to the definition of the required standards and regulations (e.g. recommendations for associated means of compliance). The demonstrations will involve performing a significant number of flights, in coordination with relevant stakeholders, and using one or more eVTOL platforms, including vehicles with full autonomous capabilities. The demonstration projects will build on the work done in SESAR 2020 on this field. Close coordination with EASA is expected to ensure complementarity and consistency with EASA activities.

2.5.3.2 *CEF-T-2021-SIMOBGEN-SESAR-DSDA-WORKS: Digital Sky Demonstrators on aviation Green Deal*

Objective

The objective of the demonstrations under this topic is to contribute to achieving the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement. This implies a need for aviation to intensify its efforts to reduce emissions, in line with the targets set in *Flightpath 2050*.

To this end, a set of operational measures to improve the fuel efficiency of flights will have to be put in place. At the same time, to ensure sustainable air traffic growth, it is necessary to speed up the modernisation of the air infrastructure to offer more capability and capacity, making it more resilient to future traffic demand and more adaptable through more flexible ATM procedures. Furthermore, reducing aircraft noise impacts and improving air quality around airports will remain priorities.

- **Environment.** The proposed operational measures will enable gate-to-gate optimal flight trajectories and demonstrate improvements to the fuel efficiency of flights, thus reducing CO_2 (and non-CO_2) emissions.
- **Capacity and operational efficiency.** The higher level of automation supporting the solutions under demonstration will make it possible to go beyond the current limits on sector capacity arising from controller workload, which will allow optimal and environmentally friendly flight trajectories.
- **Cost-efficiency.** Saving fuel for airspace users will reduce CO_2 emissions and related costs.
- **Safety.** Safety levels are to be maintained or improved, with a higher level of automation.

The objective is to achieve, for the technologies within the scope of this topic, a TRL8 maturity level ('actual system completed and mission qualified through test and demonstration in an operational environment').

The Digital Sky Demonstrator instrument will be closely connected to the standardisation and regulatory framework, and will provide a basis for achieving a critical mass of early movers representing at least 20 % of the targeted operating environment, thus accelerating market uptake.

Themes and priorities

To achieve the expected outcomes, all or some of the following should be addressed.

- **Formation flight demonstrators.** Novel airborne station-keeping capabilities in support of the WER concept, based on previous SESAR work on airborne separation assurance systems, will allow an aircraft to cruise closely behind another aircraft on the same route, thereby realising fuel savings. This activity will contribute to the operational validation of the station-keeping capabilities and pave the way for their certification. The scope includes the airborne and ATC operational requirements. It is expected that these demonstrations will allow the limited initial implementation of this concept, which will immediately realise environmental benefits *(R&I need: formation flight)*.
- **Integrated 4D for green trajectories.** This activity will demonstrate the operational benefits of ADS-C when integrated into ground systems beyond the 2D flight plan consistency check, with a focus on the environmental benefits, based, for example, on facilitating an airline's preferred trajectory using the TOD information, improved arrival management, enhanced vertical clearances delivered via radio telecommunications or CPDLC. The demonstration may combine live trials for concepts having reached TRL6 maturity in wave 1 with real-time simulations for the more advanced concepts. The scope may include alternative ATN B2 standards (ATN B2 Revision A) and/or non-European airborne platforms operating in Europe (potentially connecting via VDL2/IPS), military aircraft and business aviation aircraft. The distribution of the EPP data to the NM and their operational use in support of network operations is also in scope *(R&I need: optimum green trajectories; PJ.18-06b1, Solution 115, Milestone 1: ECAC-wide implementation of cross-border free routes, air–ground and ground–ground connectivity)*.
- **Satellite-based innovation for green trajectories.** This activity will demonstrate the environmental benefits of introducing direct controller–pilot communication (DCPC) via VHF voice communication (with the ground antennas being replaced with LEO satellite antennas but with no change to aircraft avionics) in combination with satellite-based ADS-B, satellite-based VHF voice communication and potentially satellite-based VDL2. The aim is to dramatically increase airspace capacity, thereby enabling AUs to fly closer to their preferred routes. The activity includes both the technical demonstration and an initial assessment of the potential for reducing separation minima (building on the current ICAO work on reduction of separation based on satellite-based ADS-B without DCPC, but now adding the DCPC element), as well as a quantification of the environmental benefits. The use of initial trajectory information-sharing via SatCom Class B or VDL2 (based on IPS and/or open systems interconnection) could be included in the scope of this demonstration. The activity must contribute to the ICAO's work and that of all relevant standardisation and international coordination groups *(R&I need: optimum green trajectories; Solution 109, AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR Solutions)*.
- **Green approaches through second runway aiming point and increased glide-slope concepts.** These demonstrations aim to increase the available approach vertical path

options at European airports; this increased flexibility will allow airports to reduce the environmental impact on neighbouring communities. These procedures can be based on RNP, SBAS and/or GBAS. The demonstration will take place in a real environment and result in an assessment of the environmental benefits of the new procedures *(R&I need: advanced RNP green approaches; Solutions PJ.02-W2-14.2, PJ.02-W2-14.3 and PJ.02-W2-14.5)*.

- **Green approaches through GNSS as primary navigation means, with reversion scenarios, in an operational environment.** The demonstrator will address the use of GNSS in all phases of flight including GBAS/GAST D (CAT II/III), GPS and Galileo, SBAS/GBAS complementarity, reversion from GNSS to instrument landing system, and reversion from GNSS area navigation to multi-DME (A-PNT) *(Solution PJ.14-W2-79a)*.
- **Green approaches through improved speed and aircraft configuration management on arrival.** This demonstration aims to investigate the impact of throttle and high-lift-device management on the environment. It is intended to identify quick-win airborne and ground procedures that reduce the impact on the environment without the need for updates to avionics or ground systems *(R&I need: advanced RNP green approaches)*.
- **Green climb-via and descend-via procedures, including descent-via with re-cruise options.** This demonstration builds on the SESAR Single European Sky Award-winning optimised descent profiles demonstration. It will support the implementation of the recommendation made in the continuous climb and descent operations action plan to implement the ICAO descend-via procedures, in combination with the re-cruise FMS function developed as part of the SESAR 2020 solution PJ.01-03b, which will be brought to maturity in this demonstration. The focus of the demonstration will be on addressing ground and airborne challenges in order to allow the widespread adoption of the descend-via procedures in Europe and the adoption of the re-cruise concept in order to mitigate the negative impact on the environment of early descent clearances *(R&I need: environmentally optimised climb and descent operations; Solutions PJ.01-03b & PJ.01-W2-08B, AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR Solutions)*.
- **Initial ATN B2 datalink green trajectory revision concepts.** This activity will demonstrate uplink via ATN B2 CPDLC of an ATC clearance containing a revision of the 2D route or a vertical clearance with a vertical constraint. The activity should consider both ATN B2 and ATN B2 Revision A standards (with DRNP). These clearances will be autoloaded into the FMS. The demonstration will result in an assessment of the environmental benefits and of the impact on flight-crew workload and crew resource management *(R&I need: optimum green trajectories; Solution PJ.18-W2-56, AAS TP Milestone 4: g**radual transition towards higher levels of automation supported by SESAR Solutions)***.
- **TBO for green trajectories in the planning phase (FF-ICE 1).** This activity will demonstrate the environmental benefits of the enhancements to the planning phase brought about by the FF-ICE 1 concepts, in particular the extended flight plan. The demonstration should investigate a concept to allow AUs to load less fuel thanks to the reduced uncertainty for the AU, potentially incorporating information such as planned departure and arrival runways, expected SID and STAR, and intelligent prediction of arrival sequencing and metering area time (prediction derived from demand data using ML. *(R&I need: optimum green trajectories; Solution PJ.18-02c, AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR Solutions)*.

- **Green taxiing.** This element aims to implement reduced-emissions or emission-free taxi operations at medium and large European airports, applying any of the available technologies (engine-off taxi out and taxi in, taxibots, auxiliary engines in the undercarriage), or a combination thereof. The demonstrators' focus will be on addressing the ATM aspects as required to make it possible to scale up the operations to all AUs at the airport. Attention will be paid to both nominal and adverse conditions, in particular including a de-icing process where relevant. These demonstrators will pave the way for large-scale implementation across Europe *(R&I need: accelerating decarbonisation through operational and business incentivisation)*.
- **Integrated ATM/apron management for green surface management.** This element is based on the use of cameras and ML and AI to optimise turnaround operations, linking landside and airside processes to increase the predictability of operations, improve on-time performance and optimise the use of resources such as parking stands. The concept includes the development of an operational strategy based on environmental criteria to optimise operations and mitigate environmental impact. Monitoring and promoting the reduction of operations that may have a negative environmental impact, such as the use of auxiliary power units, should also be addressed *(R&I need: accelerating decarbonisation through operational and business incentivisation; Solution PJ.04-W2-29.3)*.
- **Aviation-induced cloudiness data collection and analysis.** This demonstration will equip aircraft with advanced sensors in order to collect data relevant for the assessment of the non-CO_2 impacts of aviation (e.g. humidity, temperature, cloudiness) and integrate this information with satellite imagery data and data from other meteorological information sources/databases. The aim is to set up a data collection and data analysis concept that can continue beyond the life of the demonstration, in order to support the continuous assessment of the evolution of the atmospheric metrics that are relevant for better understanding the non-CO_2 impacts of aviation and the effects of the policy actions *(R&I need: non-CO_2 impacts of aviation)*.

2.6 Call CEF-T-2022-SIMOBGEN

A second call for proposals for Digital Sky Demonstrators has been launched on 13 September 2022, funded under the CEF programme.

2.6.1 CEF-T-2022-SIMOBGEN-SESAR-DSDU-WORKS: SESAR-DEMONSTRATORS HLA – works (Digital Sky Demonstrators on gradual transition towards higher levels of automation)

Objective: High Level of Automation Support

The Digital Sky Demonstrators (DSD) under this topic aim to increase the level of automation support in Air Traffic Management (ATM). This includes:

- **Operational efficiency and environment.** Higher automation and interoperability will result in fewer tactical interventions by air traffic control (ATC) and increase predictability, enabling airspace users to fly closer to their preferred trajectories, thus reducing fuel-burn and emissions.
- **Capacity.** The increased level of automation support to ATC will contribute to optimising the use of the airspace. Improvements in ground operations predictability and the integration of advanced tools for arrival and departure will help to optimise runway use. Better connectivity between stakeholders, higher levels of interoperability and greater predictability brought about by increased automation will increase capacity.
- **Cost-efficiency.** Increased automation support, when adopted consistently, will contribute to operational harmonisation and eventually to cost-efficiency. A service-based approach and a well-defined required service level (e.g. for Communication Navigation Surveillance (CNS) services) will also help to achieve cost-efficiencies.
- **Safety.** The automation of some procedures will ultimately lead to improved safety and fewer errors, due to better allocation of human resources creating the greatest possible added value. Additionally, increased data-sharing will also foster the early detection of potential safety issues and their mitigation.

The airspace architecture strategy (AAS) recognises that humans will remain at the centre of the system. The participation of pilots, controllers and air traffic safety electronics personnel (ATSEPs) in the DSD will contribute to assessing the human aspects of increasing the level of automation in ATM (e.g. Human Machine Interface , workload, training needs).

The Digital Sky Demonstrators will help to increase buy-in from the ATM community to Single European Sky ATM Research (SESAR) Solutions and will provide further evidence to support the business case for them. The Digital Sky Demonstrator instrument will provide a basis for achieving a critical mass of early movers, thus accelerating market uptake, facilitating the industrialisation process for SESAR solutions and promoting their deployment. All stakeholders will have an opportunity to learn and exchange practical expertise related to the introduction of SESAR solutions.

Themes and priorities:

The objective is to establish a network of Digital Sky Demonstrators to accelerate the transition to deployment of a number of SESAR solutions that are part of measure 3 under the airspace architecture study transition plan (AAS TP) in order to fully leverage breakthrough technologies that can contribute

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to the defragmentation of European skies (e.g. dynamic airspace configurations, solutions boosting the level of automation support, enhanced air-ground datalink capabilities, multilink environment, etc.).

The scope of the topic is described in terms of individual elements. A proposal shall fully cover at least one of these elements, but should also aim at addressing as many elements as possible.

- **Increased automation support.** This will cover improved conflict detection and resolution tools that are derived from the improvement of ground trajectory prediction, based for example on the use of advanced data from automatic dependent surveillance contract (ADS-C)reports, improved algorithms or improved use of meteorological data. The improvements to ground trajectory prediction may include the use of ADS-C data (e.g. gross mass, speed schedule, top of climb (TOC) and top of descent (TOD) altitudes, the predicted speeds at route points), improvements to calculations of turning manoeuvres thanks to the use of turn radius and the turning strategy (overfly versus fly-by), the implementation of catch-up manoeuvres (not depending on the extended projected profile (EPP) data), etc. *(PJ.18-W2-53B, AAS TP Milestone 6: trajectory-based operations)*.
- **New HMI interaction modes and technologies for Air Traffic Service Unit (ATSU).** The aim is to minimise the load and mental strain on controllers in ATSUs . This may include the use of in-air gestures, attention control, automatic speech recognition, user-profile management systems, tracking labels, virtual and augmented reality, etc.*(PJ.10-W2-96 AG (Attention Guidance), PJ.10-W2-96 ASR (Automatic Speech Recognition) and PJ.10-W2-96 UPMS (User Profile Management System), AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR solutions)*.
- **Flight-centric demonstrator to improve ANS productivity.** This demonstrator covers the demonstration of flight-centric operations in environments where most benefits in terms of cost-efficiency are expected (e.g. daytime high-altitude airspace and daytime or night-time low-density airspace) *(PJ.10-W2-73 FCA (Flight Centric ATC), AAS TP Milestone 5: transition to flight-/flow-centric operations)*.
- **Near-real-time traffic management in sequence- or flow-based coupled AMAN-DMAN (Arrival – Departure Management tools) environmment.** This will involve taking advantage of predicted demand information provided by local AMAN and DMAN systems and potentially include, in addition to the optimisation of runway usage, the balancing of flows in the Terminal Manoeuvring Area TMA (e.g. through the prioritisation of traffic flows where appropriate), and more consistent and manageable delivery into the en-route phase of flight, while still ensuring optimal usage of runway and TMA capacity *(PJ.01-W2-08A1, AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR solutions)*.
- **Use of enriched Demand Capacity Balance (DCB) Information and enhanced what-ifs to improve flight planning, including the Network Manager (NM) flight plan approval process.** The aim is to reduce the impact of ATM planning on airspace users' costs of operations, by providing them with better access to ATM resource management and allowing them to better cope with ATM constraints. The objective is to demonstrate solutions aimed at improving airspace users' flight planning and network management through improved Flight Operations Centre (FOC) participation in the ATM network and collaborative processes in the flight and flow information for a collaborative environment (FF-ICE) context**.** Enriched DCB information will be available to improve Airspace Users (AUs)' decision-making processes when planning or replanning

trajectories and may include DCB constraints/measures, information such as air traffic flow and capacity management (ATFCM) regulations / calculated take-off time CTOT / short-term ATFCM measures (STAM), additional DCB information such as hotspots and congestion level indicators, etc. The information (provided either for the trajectory planned by the AU as part of a submitted flight plan or for alternative trajectories considered in the context of advanced what-ifs) can be used in different use cases: proactive management of fleet delays by AUs, collaborative decision making (CDM) processes triggered by flow managers (e.g. STAM/cherry-picking measures), etc. *(PJ.07-W2-38, AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR solutions)*.

- **Improving the connectivity between regional airports and the NM.** This can be achieved thanks to the provision of departure planning information messages based on target times and a reduced set of turnaround milestones compared with full airport collaborative decision making (A-CDM) implementation. This reduced set of milestones is calculated quasi-automatically, reducing the need for airline / ground handler input. The expected benefits relate to predictability, flexibility and efficiency for all airport stakeholders, while improving stability, predictability and resilience at network level. The demonstration is expected to cover a significant number of regional airports. Note that the airports under scope are beyond those listed in Common Project One (CP1) regulation *(AAS TP Milestone 4: gradual transition towards higher levels of automation supported by SESAR Solutions)*.
- **Operating a multilink communications infrastructure.** This must include several elements, the Enhanced air-ground datalink capabilities beyond controller-pilot datalink communications services, the testing of a multilink environment and the assessment of the operational benefits of the higher performance of LDACS within that environment.
  - Firstly, the Enhanced air-ground datalink capabilities beyond controller–pilot datalink communications service is a key enabler of automation. This addresses the need of airborne users to connect to the ground by different means to support ATS B1 and in particular the B2 communication services in an operational environment with representative traffic scenarios, hence demonstrating a seamless and automatic switch between different technologies in the air and in ground, based on availability and performance needs. The demonstration shall address the prioritisation of air traffic service (ATS) messages over any other data traffic over the same link, which is not possible via VDL2.
  - Secondly, the testing of the multilink environment must include the combination of at least a terrestrial and satellite technologies from those within the Future Communication Infrastructure (FCI): namely Terrestrial L-Band Digital Aeronautical Communication System (LDACS), Satellite Satcom (ATN/IPS and OSI (Aeronautical Telecommunications Network Internet Protocol Suite / Open Systems Interconnection) and Aerodrome Technologies in an ATN IPS/OSI environment. It should address where possible both Datalink and Digital Voice. Projects may include test bed platforms, to appropriately stress test avionics equipment, space and ground systems and support validation of standards as well as certification of equipment. The end to end demonstration must include the ground, space and the aircraft components, validation of the operational interface with pilots and air traffic controllers (ATCOs) (AAS TP Milestone 6: trajectory-based operations).

- Thirdly, the demonstration of the next generation of air–ground datalink via LDACS**.** This will include within a multilink environment, the assessment of the operational benefits of the higher performance of LDACS (in particular the lower latency in combination with higher data capacity thanks to prioritisation of ATS traffic over any other traffic over the same link). Although the focus of this demonstration is datalink communications, the LDACS technology is part of the advanced integrated CNS concept; as a complement to the demonstration of the datalink aspects, the demonstration may also address the use of LDACS for alternative position, navigation and timing (A-PNT) and/or surveillance aspects, as well as digital voice via LDACS options (AAS TP Milestone 6: trajectory-based operations).

- **Integrated ground–ground back-up voice between remotely piloted aircraft system (RPAS) pilots and ATC.** The demonstration should include the retransmission of voice communications over the VHF channel in support of the seamless integration of RPAS into the European airspace *(AAS TP Milestone 6: trajectory-based operations)*.
- **The initial demonstration of the next generation of air–ground datalink via LDACS.** Nominal communications between RPAS pilots and ATC are via VHF relay to the RPAS, which means that in the event of a lost-link contingency, the remote-pilot ATC communication is also disrupted. The establishment of a back-up communication (typically phone connection) entails some delay at this critical contingency time; once established, the back-up connection via phone poses safety challenges due to the increased controller workload at a critical contingency time due to its lack of integration in the ATC communications system. The objective of this demonstration is to establish a reliable backup voice communication between the remote pilot and ATC, e.g. via phone or internet VoIP (voice over Internet Protocol) that is fully integrated into the ATC communications system. The demonstration should include the retransmission of backup with party-line voice communications over the very high frequency (VHF) channel in support of the seamless integration of RPAS into the European airspace, and could also address ground-ground backup CPDLC communications (AAS TP Milestone 6: trajectory-based operations).

Activities that can be funded:

Target maturity levels required

The demonstrations under this topic shall address a Technical Readiness Level 8 (TRL8) maturity level (‘actual system completed and mission qualified through test and demonstration in an operational environment’) for a number of SESAR solutions delivered at TRL6 level by SESAR 1 and SESAR 2020 and which will contribute to increasing the level of automation support in ATM. This covers TRL-8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or airborne): end of system development, fully integrated with relevant operational systems (people, processes, hardware and software), most user documentation, training documentation, and maintenance documentation completed. All functionalities are tested in simulated and operational scenarios. Verification, Validation (V&V) and Demonstration completed, regulatory needs and standards are finalised.

Standardisation and Regulatory activities

The demonstrators must be closely connected to the standardisation and regulatory activities. Early engagement with the regulator during the demonstration process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for the SESAR solutions under scope. With this in mind, European Union Aviation Safety Agency (EASA) and/or National Supervisory Authority (NSA) involvement through the partners must be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution must be identified in the European ATM Standards Coordination Group (EASCG) rolling plan. The work of the project must then be appropriately focused on delivering the material that is required (if applicable) for finalising regulatory needs and standards.

The following two specific deliverables addressing the regulatory activities and standards will have to be provided by the Digital Sky Demonstrators in order to guarantee the adequate consideration by the projects of the needs to coordinate closely with EASA and EASCG:

1. REG: proposed SESAR Acceptable Means of Compliance to EASA to illustrate means to establish compliance with the SES Regulations, EASA Basic Regulation and its Implementing Rules;
2. STAND: proposed SESAR Input to EASCG standardisation activities.

Expected impact:

Demonstrators will take place in live operational environments demonstrating services, technologies and standards necessary to deliver the digital European sky. This will help create buy-in from the supervisory authorities, civil and military stakeholders, manufacturers and operational staff, providing tangible evidence of the performance benefits in terms of environment, capacity, safety, security and affordability.

The establishment of a Europe-wide network of large-scale digital sky demonstrators offers a viable means to build confidence and bridge from research, through industrialisation to implementation.

2.6.2 CEF-T-2022-SIMOBGEN-SESAR-DSDA-WORKS - SESAR-DEMONSTRATORS VC – works (Digital Sky Demonstrators on virtual centres and ATM data service providers)

Objective: Virtual Centres

The objective of the demonstrations under this topic is to address the issue of the lack of flexibility in sector configuration capabilities at pan-European level clearly highlighted by the airspace architecture study. This lack of flexibility is caused by the close coupling of ATM service provision to ATS systems and operational procedures, preventing air traffic from making use of cross-border service provision and data sharing.

A more flexible use of external data services, taking into account data properties and access rights, would allow the infrastructure to be rationalised, reducing the related costs. This would enable data-sharing, foster more dynamic airspace management and ATS provision, and allow Air Traffic Service Units (ATSUs) to improve capacity in portions of airspace where traffic demand exceeds available capacity. Furthermore, it offers options for the contingency of operations and increased resilience of ATS provision.

- **Cost-efficiency.** Virtualisation in support of delegation of the provision of ATSs among ATSUs will have an impact on Air Navigation Service Provider (ANSP) capabilities in terms of resource management at both staffing and facilities level (cost optimisation).
- **Capacity/resilience.** More manoeuvring margin on resources management by the ANSP will lead to a better use of spare capacity (fewer demand measures required). More dynamic airspace management will contribute to improving capacity while responding with flexibility to airspace users' flight trajectory needs.
- **Environment.** The delegation of the provision of ATSs among ATSUs, for both cross-border and non-cross-border cases, will make ATS provision more seamless, as load balancing between ATSUs and avoidance of airspace or ATS provision disruptions will allow Airspace Users (AUs) to fly more efficient trajectories.
- The Digital Sky Demonstrators will help to increase buy-in from the ATM community to SESAR Solutions and will provide further evidence to support the business case for them. The Digital Sky Demonstrator instrument will provide a basis for achieving a critical mass of early movers, thus accelerating market uptake, facilitating the industrialisation process for SESAR solutions and promoting their deployment. All stakeholders will have an opportunity to learn and exchange practical expertise related to the introduction of SESAR solutions.

Themes and priorities:

To successfully address the expected outcomes, all or some of the following priorities should be addressed:

- **Demonstration of a new Air Traffic Service (ATS) operating model based on the delegation of ATS using virtual centres (VC).** The objective is to demonstrate the increased efficiency and resilience of the ATS thanks to better use of resources across ATSU borders; the scope includes the following elements.
  - Delegation of ATS among ATSUs based on traffic/organisation needs (either static on fixed-time transfer schedule (e.g. day/night) or dynamic e.g. when the traffic density is below/above a certain level) or on contingency needs.
  - ATFCM aspects in support of the delegation of ATS, including the interaction with the Network Manager (NM) on dynamic sectorisation and flow allocation. This may include the dynamic delegation of ATS provision for load balancing (ATFCM), cross-border rostering concepts, etc. The delegation of the ATFCM service provision between ATSUs may also be considered.
  - Civil–military aspects of delegation of ATSs (e.g. delegation of ATS provision between civil and military ATSUs). The digitalisation of ATC systems enables virtualisation approaches in which remote operations become an important contributor to resource pooling and rationalisation. Civil–military ATSUs will be able to delegate the airspace to another ATSU as long as there is guarantee of seamless ATS provision in the delegated airspace. Virtual control centres allow for more efficient and flexible use of resources, with civil–military synergies.
  - The Air Traffic Controllers (ATCOs) receiving the delegation of airspace need to be in possession of the appropriate qualification; the demonstration may include complementary concepts in support of increased flexibility in ATCO validations (e.g. validations for working in a sector restricted to a certain configuration, such as

airports/TMAs that are closed at night, sectors combined, etc.), standardisation of procedures and performance support tools to reduce the number of hours required to be current in a sector, so as to make it possible for ATCOS to controlmore sectors, etc. *(PJ.16-03, PJ.10-W2-93 and PJ.32-W2-01, AAS TP Milestone 3: virtual centres and dynamic airspace management at large scale)*.

- Demonstration of new ATS operating model based on the ATM data service providers (ADSPs) concept outlined in the airspace architecture study and later complemented by a European Commission study (European Commission study number MOVE/E3/SER/2018-580/SI2.813340) In the Commission study, ATM data services are defined as services that provideATSUs, airspace users, airports and other operational stakeholders with information on the intended movement of each aircraft, or changes thereto, and with current information on the actual progress of each aircraft, based on operational data received from surveillance services, aeronautical information services, meteorological services, network functions and any other relevant operational data.
  - The scope includes the demonstration of new operating models based on the opportunities opened up by the new service delivery model (e.g. provision of flight data processing and integration services, provision of surveillance data processing and integration services, new services related to ATM data transformation and/or processing dependent on or related to outputs from flight data processing and/or surveillance data processing, services for remote technical monitoring of distributed systems). The development of the technical enablers in support of the new services is also in scope; this includes in particular the ATSEP support tools to support the efficiency of the ATSEP distributed team.
  - The DSD is an opportunity to address the military concerns (e.g. security) on the ADSP concept;
  - The proposed demonstrations must be aligned with the scope of ATM data services in each of the data categories and take into account interfaces with other services or functions and the actors feeding into or consuming the ATM data services, as defined in the European Commission study.
  - These demonstrations should help to overcome the challenges associated with regulatory and certification issues. Close cooperation with European Union Aviation Safety Agency (EASA) and/or national regulators is therefore essential to the success of the demonstrations; the demonstrations should aim to achieve the certification of the first ADSP(s) in Europe *(PJ.16-03, PJ.10-W2-93 and PJ.32-W2-01, AAS TP Milestone 3: virtual centres and dynamic airspace management at large scale)*.
- **Demonstration of dynamic airspace configurations.** This will entail demonstrating in an operational environment the combination of dynamic airspace management and airspace configurations level 0, digital integrated network management and ATC planning (INAP) and dynamic mobile area (DMA) type 1. DMA type 1 is a volume of airspace of specified dimensions described as an integral part of the Mission Trajectory (MT) at flexible geographical locations agreed upon in a CDM process (as part of the mission trajectory negotiation); this solution aims to satisfy military training needs while minimising the impact on civilian traffic. The demonstration's scope includes the consideration of initial mission trajectory management capability at subregional/local level in the ATM planning phase to support the dynamic configuration of segregated airspace, thus contributing to the efficiency of both civil and military operations. The

objective is to demonstrate improvements in the use of airspace capacity for both civil and military AUs, with increased efficiency in airspace management and increased flexibility in civil–military coordination. The scope of the demonstration includes the digital transformational technology impact on collaborative decision making (CDM), mission trajectory management (MTM) and airspace management (ASM) (e.g. ATCO support systems: ATCO screen to show active DMAs in real time and system support for revising trajectories of aircraft that are planned to go into a DMA) *(PJ.07-W2-40 and PJ.09-W2-44, AAS TP Milestone 3: virtual centres and dynamic airspace management at large scale)*.

Activities that can be funded:

Target maturity levels required

The demonstrations under this topic must address a technological readiness level 8 (TRL-8) maturity level ('actual system completed and mission qualified through test and demonstration in an operational environment')) for a number of SESAR solutions delivered at TRL6 level by SESAR 1 and SESAR 2020.. This covers TRL-8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or airborne): end of system development, fully integrated with relevant operational systems (people, processes, hardware and software), most user documentation, training documentation, and maintenance documentation completed. All functionalities are tested in simulated and operational scenarios. Verification, Validation (V&V) and Demonstration completed, regulatory needs and standards are finalised.

Standardisation and regulatory activities

The demonstrators must be closely connected to the standardisation and regulatory activities. Early engagement with the regulator during the demonstration process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for the SESAR solutions under scope. With this in mind, European Union Aviation Safety Agency (EASA) and/or National Supervisory Authority (NSA) involvement through the partners must be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution must be identified along with the development of standards identified in the European ATM Standards Coordination Group (EASCG) rolling plan . The work of the project must then be appropriately focused on delivering the material that could be required for finalising the regulatory needs and standards.

The following two specific deliverables addressing the regulatory activities and standards will have to be provided by the Digital Sky Demonstrators in order to guarantee the adequate consideration by the projects of the needs to coordinate closely with EASA and EASCG:

1. REG: proposed SESAR Acceptable Means of Compliance to EASA to illustrate means to establish compliance with the Basic Regulation and its Implementing Rules;
2. STAND: proposed SESAR Input to EASCG standardisation activities.

Expected impact:

Demonstrators will take place in live operational environments demonstrating services, technologies and standards necessary to deliver the digital European sky. This will help create buy-in from the supervisory authorities, civil and military stakeholders, manufacturers and operational staff, providing tangible evidence of the performance benefits in terms of environment, capacity, safety, security and affordability.

The establishment of a Europe-wide network of large-scale digital sky demonstrators offers a viable means to build confidence and bridge from research, through industrialisation to implementation.

2.7 Call CEF-T-2023-SIMOBGEN

A third call for proposals for Digital Sky Demonstrators will be launched mid-13 September 2023, funded under the CEF programme. The call will contain provisions for establishing Europe as the most efficient and environmentally friendly sky to fly in the world. The demonstrators will contribute to achieving the objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement. The call will also enable a more flexible, scalable, resilient, safe and secure ATM that can withstand disruptions in the aviation system through a phased but substantial progress on the deployment of the future European airspace architecture (Airspace Architecture Study Transition Plan (AAS TP)) and contribute to the digital transformation of air navigation service provision.

More detailed technical specifications will be made available in the call for proposals for EU action grants in the field of transport under the Connecting Europe Facility (CEF) that will be published in the CINEA portal.

3 Annex III. List of members of the SESAR 3 Joint Undertaking

The full list of SESAR 3 JU members and their constituent entities is published on the SESAR 3 JU website.

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