Draft proposal for a

European Partnership under Horizon Europe

Integrated Air Traffic Management

July 2020

Summary

Digital transformation of ATM, making the European airspace the most efficient and environmentally friendly sky to fly in the world, supporting the competitiveness and recovery of the European aviation sector in a post-COVID crisis Europe. Key areas: improving connectivity, air-ground integration and automation, increasing resilience and scalability of airspace management, safe integration of autonomous vehicles. Deliver by 2030 the solutions identified in the European ATM Master Plan for Phase D at TRL 6 while significantly increasing market uptake for a critical mass of early movers focusing on Phase C and D infrastructure modernisation priorities.

About this draft

In autumn 2019 the Commission services asked potential partners to further elaborate proposals for the candidate European Partnerships identified during the strategic planning of Horizon Europe. These proposals have been developed by potential partners based on common guidance and template, taking into account the initial concepts developed by the Commission and feedback received from Member States during early consultation[1]. The Commission Services have guided revisions during drafting to facilitate alignment with the overall EU political ambition and compliance with the criteria for Partnerships.

This document is a stable draft of the partnership proposal, released for the purpose of ensuring transparency of information on the current status of preparation (including on the process for developing the Strategic Research and Innovation Agenda). As such, it aims to contribute to further collaboration, synergies and alignment between partnership candidates, as well as more broadly with related R&I stakeholders in the EU, and beyond where relevant.

This informal document does not reflect the final views of the Commission, nor pre-empt the formal decision-making (comitology or legislative procedure) on the establishment of European Partnerships.

In the next steps of preparations, the Commission Services will further assess these proposals against the selection criteria for European Partnerships. The final decision on launching a Partnership will depend on progress in their preparation (incl. compliance with selection criteria) and the formal decisions on European Partnerships (linked with the adoption of Strategic Plan, work programmes, and legislative procedures, depending on the form). Key precondition is the existence of an agreed Strategic Research and Innovation Agenda / Roadmap. The launch of a Partnership is also conditional to partners signing up to final, commonly agreed objectives and committing the resources and investments needed from their side to achieve them.

The remaining issues will be addressed in the context of the development of the Strategic Research and Innovation Agendas/ Roadmaps, and as part of the overall policy (notably in the respective legal frameworks). In particular, it is important that all Partnerships further develop their framework of objectives. All Partnerships need to have a well-developed logical framework with concrete objectives and targets and with a set of Key Performance Indicators to monitor achievement of objectives and the resources that are invested.

Aspects related to implementation, programme design, monitoring and evaluation system will be streamlined and harmonised at a later stage across initiatives to ensure compliance with the implementation criteria, comparability across initiatives and to simplify the overall landscape.

A Strategic Research and Innovation Agenda for the partnership (SRIA) is currently being developed by the stakeholders, under the coordination of Eurocontrol, in line with the newly adopted European ATM Master Plan Edition 2020 and this High Level Partnership Proposal. A public consultation is due to launch in the end of July 2020. It will be followed by a stakeholder workshop in September.

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[1] https://www.era-learn.eu/documents/final_report_ms_partnerships.pdf

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1 Executive Summary

Despite significant progress with modernising air traffic management (ATM) infrastructure in the past decade, up to 10% of CO_2 emissions generated by flights are caused by a fragmented ATM infrastructure that does not fully exploit the advantages of digitalisation and automation, and these emissions could be avoided.

Furthermore, while the economic outlook resulting from the COVID 19 pandemic is too early to predict, it is clear that due to its nature, air transport has been among the hardest hit sectors. The pressure on the ATM infrastructure to become more cost-efficient, resilient and scalable to fluctuations in traffic as well as to accommodate new types of air vehicles has never been higher.

The duration of the innovation cycle in ATM should also be reduced, allowing industrial players in the sector to remain competitive and support a wide range of applications in transport (e.g. passengers, cargo, drones & urban air mobility), defence & security (civil-military cooperation in airspace management).

Addressing these multiple challenges in a rapidly evolving and demanding context requires a significant collective effort to boost cooperation and investment on breakthrough innovations to realise the overall concept of "digital European sky"[2] and meet the following three objectives that cannot be addressed by any single stakeholder or Member State alone as, by essence, aviation is international and requires common and coordinated action:

1) Bring the European ATM into the digital age to make it more resilient and scalable to fluctuations in traffic
2) Strengthen the competitiveness of EU air transport, drones and ATM services markets to support economic growth and recovery in a post COVID-19 context in the EU
3) Establish the European airspace as the most efficient and environmentally friendly sky to fly in the world.

Europe has a unique opportunity, as the world leader in aviation infrastructure technology, to realise these objectives. However, success will only be possible with a strong industrial partnership supported by an evolution in the regulatory framework to promote and accelerate innovation. The overall resource requirement to meet this challenge inside the Horizon Europe timeframe is likely to represent EUR 2.9 billion in research & innovation efforts alone, with several times this amount in private sector investment to roll-out the new capabilities across the network (~EUR 40-50 billion for the period from 2021 according to the European ATM Master Plan[3]). To have an impact, the R&I effort would require investments of up to EUR 2.9 billion.

[2] The concept of a "digital European sky" was first proposed by the SESAR Joint Undertaking in 2017, and then further developed as the heart of the SESAR vision described in the 2020 edition of the European ATM Master Plan. The Master Plan represents today the agreed roadmap by stakeholders from across the aviation community for modernising Europe's ATM. The Wise Person's Group, established by the European Commission to provide recommendations on the future of the Single European Sky and the subsequent joint declaration by industry, also supported this vision.

[3] European ATM Master Plan, Section 6

2 Context, objectives, expected impacts

2.1 Context and problem definition

2.1.1 Context in which the partnership is considered

Achieving the ambitious goal of climate neutrality by 2050 calls for the EU to ensure a deep decarbonisation of the air transport sector. The aviation industry has committed in the long-run to bring into service a new generation of aircraft that will be cleaner and quieter (based on alternative propulsion systems, new airframes and energy sources). However, this ambitious target cannot be achieved if ATM does not allow aircraft and airspace users to fully exploit their potential and thus to reduce emissions to a maximum.

Therefore, ATM must evolve at a faster pace than today to bring environmental benefits in the shorter term. Indeed, despite the ATM modernisation efforts undertaken in the past years, 5 to 10% of CO2 emissions[4] generated by flights are still thought to be avoidable and caused by a fragmented ATM infrastructure that does not fully exploit the advantages of digitalisation and automation. The avoidable emissions can be explained by unnecessarily long trajectories, congestion in the air and at airports, and thus higher CO2 emissions, delays and higher costs for the provision of air navigation services.

Furthermore, while the economic outlook resulting from the COVID 19 pandemic is too early to predict, it is clear that due to its nature, air transport has been among the hardest hit sectors. IATA, the aviation industry's trade body, has warned that some 25 million jobs in both the aerospace and aviation sectors are at risk if governments do not step in with lifelines5. These are not normal times and the pressure on the ATM infrastructure to embrace a more digital future to become more cost efficient, resilient and scalable to fluctuations (up or down) in demand for air transport has never been higher. Moreover, experiences from previous crises situations have shown that traffic will pick-up and increase beyond the pre-crises levels.

Innovation in ATM has progressed over the past decade thanks to the SESAR programme However, there are still a number of remaining challenges, including the very sub-divided ATM systems as explained above, which will require a more rapid digitalisation of the ATM infrastructure to further focussing efforts and acceleration of the development, industrialisation and market uptake of innovations that would increase the level of collaboration and automation in ATM through a data rich and cyber-secured connected ATM ecosystem. Such an evolution also poses a number of regulatory challenges as the sovereignty of Member States in relation to their airspace needs to be respected and a higher degree of digitalisation and automation would make service delegation agreements between States less important.

The sector is still at the early stages of decarbonisation and digitalisation, and massive investments across the entire air transport value chain are necessary to shorten the innovation life cycles (from approximately 30 years today to 5-10 years). In order to achieve this acceleration, ATM must tackle risks such as market failure for first movers, fragmentation among players and lack of critical mass. The ATM industry supports a wide range of applications in transport (passengers and cargo, new emerging forms of mobility such as urban air mobility), defence & security (military, law enforcement), the digital economy (such as drones for the collection of data or to bring Internet connectivity to rural and remote communities).

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[4] European ATM Master Plan Edition 2020

[5] IATA Press Release No 28 07 April 2020

In this rapidly evolving and demanding context, the status quo is obviously not an option. Addressing these multiple challenges in a rapidly evolving and demanding context requires a significant collective effort in boosting cooperation and investment on breakthrough innovations that cannot be addressed by any single stakeholder or Member State alone as, by essence, aviation is international and requires common and coordinated action.

What has or is being achieved so far

In twelve years, the SESAR JU brought all European ATM Research initiatives under a single cooperative effort and governance involving a wide range of stakeholders and the European Commission. Driven by the Union's Aviation Strategy and the European ATM Master Plan, the work of the SESAR JU plays a key role in delivering the much needed technological progress to support the success the Union's Single European Sky policy. Some key figures to illustrate the results so far:

i) The Exploratory Research (ER) phase investigates innovative concepts and ideas with lower maturity on both transversal topics for future ATM evolution and application-oriented research to date, SESAR 2020 (from 2014 to 2024) has delivered 259 prototypes and 344 feasibility activities; SESAR 2020 projects have made 123 publications in peer-reviewed high-impact journals; 3 patents have been awarded,

ii) The pipeline then expands into the Industrial Research and Validation (IR) phase where SESAR Solutions are developed. These Solutions are concrete operational and/or technological products that provide the potential for the improvement of the performance of the ATM system and the objectives of the SES. They are matured through the European Operational Concept Validation Methodology (E-OCVM) control and monitoring process, which is linked to Technology Readiness Level (TRL). SESAR 1 (from 2009 to 2016) delivered 350 validation exercises across all Europe, 30.000 flight trials, 90+ industrial prototypes. In total, the SESAR R&I programme plans to deliver 140 SESAR Solutions by 2024, of which 115 would be ready for deployment. 67 of these Solutions have been delivered 'ready for deployment' through SESAR 1, the rest being planned to be delivered through SESAR 2020.

iii) The SESAR JU then organises Very Large-scale Demonstrations (VLD) of the matured concepts and technologies, once ready for deployment, in representative environments.

What are the key areas for improvement & unmet challenges / lessons learnt from the current JU?

A number of systemic challenges already identified in the interim evaluation of SESAR JU[6] risk derailing the progress already achieved and will have to be better addressed in a new ATM research initiative. These challenges include:

i) The need to have more stable long-term objectives

ii) Reinforcing the accountability of the SESAR JU and prioritising EU support to R&D solutions that promote defragmentation and a competitive environment[7].

iii) Shortening the long research and industrialisation cycles, to secure a faster deployment and entry into operations of SESAR solutions;

[6] Commission Staff Working Document - Interim Evaluation of the Joint Undertakings operating under Horizon 2020, {SWD (2017) 339 final}

[7] Single European Sky: a changed culture but not a single sky, Special Report 18/2017, European Court of Auditors.

iv) Addressing funding concentration, and the need to ensure that there is enough transparency and openness to new participants, especially to entities from countries where participation was so far low;

v) Improving knowledge management and transfer, links to academia and research institutes to improve the scientific base on ATM in the EU.

2.1.2 Problem definition

Given the scale of the challenges identified, the current scientific, technological and economic positioning of Europe in the field and the overarching Single European Sky policy context, three problems, all linked to limited scientific capacity and fragmentation of R&I efforts have been identified where coordinated EU research and innovation has an essential role to play

Problem 1: The current ATM systems and technologies in the EU are not digitalised and are therefore not able to effectively adapt to the fluctuations in demand for ATM services

Digitalisation has transformed a wide range of industries (with banking, media, retail, travel & tourism, and automotive as front runners) driven by data exchange, connectivity and automation. Transformation of the aviation industry and its supporting ATM infrastructure has already started, but in a post COVID 19 world, much deeper disruptions are expected to impact this traditional, vertically integrated, industry, characterised by slow development cycles and asset intensity.

These disruptions will come from increased and renewed demand to access the sky, new entrants reinventing mobility, new services enabled by data, faster innovation cycles, or customer expectations based on standards set by digital businesses.

They will come at a time of a very challenging outlook for the aviation industry that has been hit extremely hard by the COVID-19 crisis—even harder, perhaps, than by the events of 9/11 and the 2008 global financial crisis put together. However, this challenge will also come along with value migration within the value chain and between incumbents and new players – coming both from the digital industry and from regions such as Asia which may be in a position to benefit from the ongoing rebalancing of economic power.

Despite the successful deployment of some technologies developed under the SESAR project, Europe's ATM infrastructure is still fragmented[8] and operates with a low level of automation support[9] and data exchange intensity (the primary communication technology in ATM today is high frequency radio through which decisions are exchanged by voice between air traffic controllers and pilots). This is the result of years of bespoke operations by national air navigation service providers that have until recently not sufficiently embraced digitalisation. As such, the current systems are monolithic, rigid, not scalable (i.e. providing the service where it is needed, in the amounts needed) and unable to exploit emerging digital technologies.

As a result, the periodic (e.g. weekdays vs weekends schedule) or occasional capacity shortage (leading to congestion) caused by unexpected traffic developments cannot be adequately addressed, and the new challenges, mainly the emergence of new airspace users (e.g. delivery drones), risk worsening the situation unless a new impetus is given to ATM modernisation through innovation. Many of the innovations needed are not "business as usual" or incremental but breakthrough solutions that combine digital and physical infrastructure capabilities that

[8] Single European Sky: a changed culture but not a single sky, Special Report 18/2017, European Court of Auditors.

[9] European ATM Master Plan, Edition 2020, Figure 4

needs to be deployed in the entire ecosystem by air navigation service providers, airlines or airports.

Bringing these innovations to scale in the market is challenging considering the high degree of technological, regulatory or market risk the aviation industry faces, which so far has deterred or delayed private investment in its infrastructure[10]. Addressing the multiple ATM challenges requires significant R&I investment in boosting cooperation and investment on innovations that cannot be addressed by any single stakeholder or Member State alone as the ATM infrastructure is shared and needs to rely on homogeneous standards[11], fit for the digital age, to foster innovation.

As seen prior to SESAR, national R&I programmes aimed at solving local problems, rather than addressing the network perspective at European level. This resulted in duplication of efforts on similar topics[12], leading to the adoption of different solutions generating even more fragmentation and inefficiencies. Finally, substantial R&I effort and coordination is still needed to improve the manufacturability of tomorrows digital ATM platforms and time to market to reduce innovation cycle from about 30 years to about 5-10 years.

This is due to the complexity of facilitating interactions between innovators, early movers and regulators to help develop regulatory frameworks that allow the benefits of digital technologies to be fully realised in a safety critical sector of our economy.

Problem 2: The European ATM system and technologies are not designed to accommodate an increasing number of new forms of mobility and air vehicles that are more autonomous and use digital means of communication and navigation. Moreover, current technologies do not effectively facilitate cross-border service provision in the internal market.

Over 23,000 daily flights carrying one billion passengers per year (in 2018) connect Europe's citizens, businesses, communities and cultures.

Hence, under normal circumstances with a saturated aviation infrastructure, air traffic in Europe is hitting its limits both in the air and on the ground, resulting in growing delays and unnecessary emissions. In addition, a multitude of new types of air vehicles, such as delivery drones and air taxis, will soon be seeking access to the airspace. The need for continued and more focussed coordinated R&I and validation of commonly agreed concepts is clear and urgent, in particular to support a robust economic recovery of Europe after the COVID 19 crisis.

The current European ATM infrastructure is reaching its limit in terms of ability to manage an ever increasing volume of air traffic[13] which means that the problem will resume as the COVID 19 crisis is over (at the time of writing this report the estimated time to recovery for airlines is estimated at 3 to 18 months[14] although some experts expect it to take at least 3 years). In 2018, air traffic delay attributable to the ATM short-comings doubled[15]. With sustained long-term traffic growth forecasted for the next 17 years resulting in a total traffic increase of 50%[16] there

[10] Blueprint for a Digital European Sky, Publication Office of the European Union, ISBN 978-92-9216-129-3
[11] The role of standards is discussed further in Annex 6.
[12] R&I prior to SESAR is described in Annex 6
[13] Annex 6 provides further details of the limitations of the current ATM system.
[14] The Post-COVID-19 Flight Plan for Airlines, The Boston Consulting Group, March 31 2020
[15] Eurocontrol Performance Review Report 2018: ATFM delay in 2018 was 1.74 minutes per flight; in 2017 it was 0.82 minutes per flight.
[16] European Aviation in 2040 Challenges of Growth, Annex1 Flight Forecast to 2040, EUROCONTROL, 2018

is a risk that the level of delays could be 15 times higher if the capacity of current systems is not increased[17].

The figure below shows the predicted levels of delay and congestion in 2035[18] if more flexible, scalable and interoperable ATM solutions are not developed and implemented.

Figure 1 Predicted delays and congestion levels by 2035

When the airspace management capacity limit is reached, in order to maintain safety, additional constraints are imposed on flights (e.g. delaying or re-routing flights to avoid the saturated zone), resulting in delayed and longer flights, which impact negatively on the environmental and performance goals[19] of ATM[20].

Aircrafts flying in European skies are also becoming more autonomous, more connected, more intelligent, and more diverse[21]. This means that there will be an emergence of a multitude of new types of air vehicles where there is no pilot to talk to: drones flying at low altitude, military medium altitude long endurance unmanned aircraft systems, automated air taxis, super-high altitude operating aircraft.

The markets for these "new entrants" are hindered by the lack of an integrated and harmonised traffic management concept and infrastructure that will allow the safe introduction of services and functionalities to support these operations in both new (e.g. urban) and traditional airspace. Without such systems to ensure safe operations, rules tend to be more restrictive and diverse between EU Member States[22].

Problem 3: The performance of ATM is not optimised in particular from an environmental perspective resulting in unnecessary greenhouse gas emission

There is growing pressure on the aviation sector to reduce its environmental footprint. Citizens in general and air passengers in particular increasingly expect eco-friendly, smart and personalised mobility options that allow them to travel seamlessly and efficiently. They want quick and reliable data to inform their travel choices, not only on schedules, prices and real-time punctuality, but increasingly also on environmental impacts. To deliver this new era in aviation, leveraging technology is key, as in the upcoming future new aircraft and infrastructure capabilities combined with regulatory changes hold the greatest promise to address climate changes in a post-pandemic aviation sector.

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[17] A proposal for the future architecture of the European airspace, SJU, 2019
[18] Source: A proposal for the future architecture of the European airspace, SJU, 2019.

[19] ATM performance requirements are regulated under Commission Implementing Regulation (EU) 2019/317 of 11 February 2019 laying down a performance and charging scheme in the single European sky
[20] In 2019, horizontal flight efficiency increased from 2.83% to 2.95% (https://www.eurocontrol.int/prudata/dashboard/vis/2019/) as a result of measures to reduce delay by diverting traffic from congested areas (https://www.eurocontrol.int/news/seven-measures-counteract-severe-delays).
[21] Blueprint for a Digital European Sky, Publication Office of the European Union, ISBN 978-92-9216-129-3
[22] See for example: https://dronerules.eu/en/professional

Indeed, while an energy transition (e.g. sustainable aviation fuels) is the only way in the long term (2050) to ensure carbon neutral air transport in the future, the ATM infrastructure in particular can be modernised at a more rapid pace and bring significant environmental benefits in the shorter term[23].

Today 5-10% of air transport's CO2 emissions could be avoided due to inefficiencies in the ATM infrastructure[24] as aircraft trajectories are not sufficiently optimised from gate-to-gate perspective to reduce the environmental footprint of each flight (see figure below). This is not negligible and would save 28 million tonnes of CO2 per year, which is roughly equivalent to the CO2 produced by 3.2 million people or the population in the metropolitan area of a city like Madrid[25].

To further understand the problem it is important to stress that the contribution of ATM infrastructure in reducing the climate change impacts of aviation can best be achieved by enabling aircraft to fly on their optimum (where applicable cross-border) 4D trajectory on the ground, in the climb, on-route and descent phases of flight - the optimum horizontal path from departure to destination flown at the most fuel efficient altitude. This is not the case today as illustrated by the figure below. There are several factors that may influence whether such an optimum trajectory may be flown. One factor is data sharing, as all actors (e.g. airline, airports at departure and arrival, network manager and often multiple national air navigation and data service providers) involved in the execution of a given flight will have to plan and execute their services based on a shared an agreed 4D trajectory[26]. This call for a very broad engagement of stakeholders in the future partnership as later described in section 1.4.

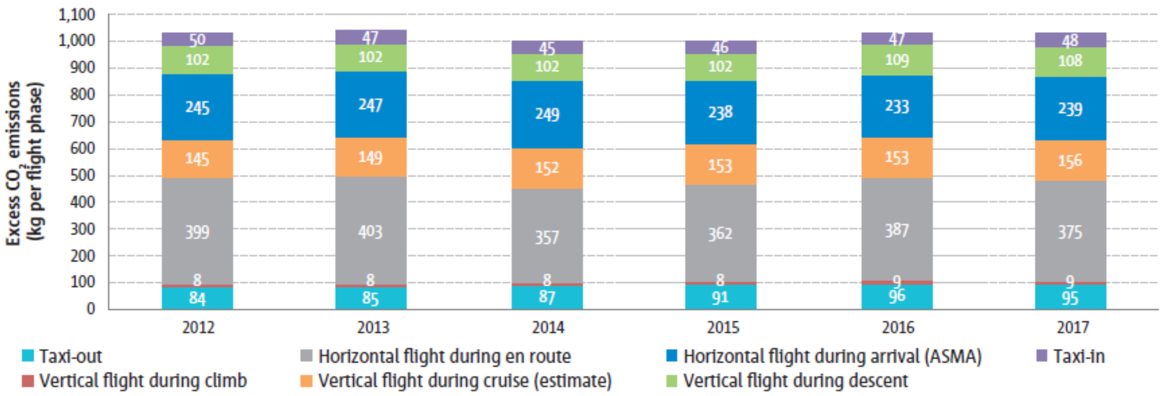

Figure 2 Breakdown of gate-to-gate excess CO2 emissions for an average flight in Europe[27]

Significant R&I effort is still needed to develop ATM technology enabling "perfect flights by design" (including for the next generation aircraft that will be cleaner and quieter) from an emission perspective eliminating all possible ATM infrastructure constraints that would result into a degradation of the optimum and thus generating extra emissions.

<u>How will the problem(s) evolve?</u>

Unless the three problems linked to limited scientific capacity and fragmentation of R&I efforts are effectively addressed at EU level, it is likely that national programmes will re-emerge on

[23] IATA, Aircraft Technology Roadmap to 2050 which provides an overview and assessment of technology opportunities for future aircraft, including improved engine efficiency, aerodynamics, lightweight materials and structures as well as radical new configurations and propulsion systems

[24] European ATM Mater Plan, Edition 2020, Figure 10

[25] European ATM Master Plan Companion Document on the Performance Ambitions and Business View

[26] ICAO Environmental Report 2019

[27] Source: European Aviation Environmental Report 2019, EASA, EEA and Eurocontrol

an ad-hoc basis, especially in a post-COVID 19 world, to solve specific local issues generating increased fragmentation.

In these circumstances, the technological problem will lead to:

- **Inability to adjust to crisis situations and to support growth:** after the financial crisis in 2008 it took until 2016 for the number of flights in Europe to return to the levels seen in 2007. In the current situation, not only have we seen airlines either stop flying or operate at a "de minims" level, but airports close for flights too. Restarting is going to be a significant activity and should not be underestimated. This crisis provides nothing more than some "breathing space" for an ATM infrastructure that had already reached its structural capacity limits. The pressure on the ATM infrastructure to embrace a more digital future to become more cost efficient, resilient and scalable to fluctuations (up or down) in demand for air transport has therefore never been higher.
- **Loss of competitiveness of European industry players**: the industry has been one of the hardest hit with the COVID 19 crisis, with contracts cancelled, production halted and pleas for big bailouts. Unlike many other sectors in the digital economy, Europe is currently the world leader in aerospace and aviation infrastructure technology. Unless this opportunity is taken it is likely that Europe will lose its leadership position and become more dependent on imports from third countries.
- **Unlikely or untimely uptake of innovation** (i.e. lack of a common vision and needed evidence for standardisation and regulatory approval) that would therefore be less likely to be deployed to overcome inefficiencies at EU level, thus making it more difficult, time consuming and expensive to make the ATM system fit for addressing future challenges.

The economic problem described above will lead to:

- **Reduced contribution to EU economy from autonomous air vehicles**: drones provide new capabilities for government and defence applications, as wells as for commercial business opportunities. The spread and development of civil drones depends on their ability to operate in various areas of the airspace. This requires significant R&I on drone traffic management[28] that, if not addressed, would reduce the estimated value of European drone market by EUR 10 billion annually by 2035 and over EUR 15 billion annually by 2050[29].

From an environmental perspective:

- **Transition to climate neutrality for the whole sector cannot be reached:** the aviation industry has committed in the long-run to bring into service a new generation of aircraft that will be cleaner and quieter (based on alternative propulsion systems, new airframes and energy sources) but this ambitious target cannot be achieved if ATM does not allow them to fly full exploiting their potential. ATM must evolve at a faster pace to bring environmental benefits in the shorter term.
- **Aircraft will fly inefficient routes, increasing environmental impact:** airspace congestion would impose inefficient routes on flights, increasing environmental impact (additional 30 to 60 million tonnes of CO_2 over the period 2019-2035[30]), and costs to airlines and passengers.

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[28] Including technological solutions for conflict avoidance and better communications between the drones and other actors, security & cyber reliance, along with the availability of authorised & safe testing environments.

[29] European Drones Outlook Study – Unlocking the value for Europe, SJU, 2016.

[30] G.3.2 of A proposal for the future architecture of the European airspace, SJU, 2019.

Problem drivers

Effectively addressing these problems at EU level will require focus on tackling the following problem drivers:

- **Lack of interoperability and fragmentation of current ATM systems:** the current infrastructure is the result of historical operational and technical evolutions, primarily conducted at the national level, which have led to today's fragmented system.
- **Limited flexibility and scalability of ATM service provision:** although the situation has improved, each air navigation service provider optimises its resources and capacity locally (through airspace organisation and staff availability).
- **Long R&I and deployment cycles:** the safety and security-critical nature of the infrastructure is one of the reasons behind slow uptake, as each innovative solution needs to be proven not to decrease safety, or security and that it complies with national, regional and world-wide standards.
- **Fast development of the new air vehicles and future business models:** new forms of air vehicles are emerging at an unprecedented rate – in particular drones and air taxis for urban air transport. At the moment, the infrastructure that would allow for, and safely manage this type and magnitude of operations, does not exist.
- **The changing role of the human in ATM:** digitalisation, automation virtualisation will generate a substantial change in the way ATM is organised and operated. No change of such magnitude can be successful without the implication and support of the staff concerned.

2.2 Common vision, objectives and expected impacts

2.2.1 General objectives of the initiative

Based on the identified problems, the overall objective of the proposed European Partnership is to develop and validate ATM technological solutions that support the achievement of the Digital European Sky making the European airspace the most efficient and environmentally friendly sky to fly in the world and support the competitiveness and recovery of the European aviation sector in a post-COVID crisis Europe.

The work to be carried out by the initiative will enable a substantial transition from current ATM systems to the new Digital European Sky vision of the European ATM Master Plan and will produce noticeable, quantifiable contributions to growth and climate targets in 2030 and pave the way for climate neutrality by 2050.

There is a significant change in scope compared to the current SESAR JU, with more focus on breakthrough innovations, industrialisation and market uptake. The following general objectives have been identified:

- Strengthen and integrate the EU's R&I capacity to bring European ATM into the digital age to make it resilient, scalable to fluctuations in traffic while enabling the seamless operation of the next generation of aircraft, which will be cleaner, quitter and more autonomous,
- Strengthen through innovation the competitiveness of EU air transport, drones and ATM services markets to support a robust economic growth and recovery,
- Develop and accelerate market uptake of innovative solutions to establish the European airspace as the most efficient and environmentally friendly sky to fly in the world

These objectives address the aviation value chain, which was severely affected by the COVID 19 crisis, from a broad perspective and are aligned with the objectives of the Horizon Europe framework. Their achievement will contribute to several Sustainable Development Goals with the most impact on SDG 9 (Industry, Innovation and Infrastructure), SDG 13 (Climate Action) and SDG 8 (Decent work and economic growth).

2.2.2 Specific objectives of the initiative

The future partnership will only be successful if all partners will continue to remain committed to the objectives established by the European ATM Master Plan. Significantly more efforts and investment than in the past are needed from all stakeholders involved to ensure the delivery of technical solutions able to advance smoothly through standardisation and certification processes.

Therefore, in order to achieve the general objectives, five specific objectives are defined. They respond to each of the problem drivers discussed in Section 1.2:

- Develop an R&I ecosystem covering the entire ATM and U-space value chains allowing to build the Digital European Sky, enabling the collaboration and coordination needed between air navigation services providers and with airspace users to ensure that a single harmonised EU ATM system for both manned and unmanned operations.
- Develop and validate breakthrough ATM solutions supporting high levels of automation.
- Develop and validate the technical architecture of the Digital European Sky
- Foster accelerated modernisation of ATM infrastructure through a network of demonstrators
- Maintain a consensus-led strategy for EU ATM modernisation

Successful measurement of the implementation of the afore-mentioned specific objectives should be measures against the capacity of the future partnership to execute the following core activities:

- Organise and coordinate the SESAR definition, development [and industrialisation] phases to stimulate and reinforce the EU scientific, operational and industrial ecosystem for innovation in aviation infrastructure;
- Develop and validate breakthrough ATM solutions supporting high levels of environmental performance, resilience and scalability. The objective by 2030 is to deliver the solutions identified in the European ATM Master Plan for Phase D (“Digital European Sky”) at TRL 6;
- Accelerate market uptake by establishing a European network of large-scale digital sky demonstrators to build confidence and bridge the gap between research and implementation. The demonstrators should be closely connected to the standardisation and regulatory frameworks to advance the maturity of the solutions smoothly through standardisation and certification processes. The objective by 2030 is to accelerate market uptake (up to TRL 8) for a critical mass of “early movers” representing minimum 20% of the targeted operating environment in Europe.
- Facilitate interactions between breakthrough innovators, early movers and regulators to help develop regulatory frameworks that allow the benefits of digital technologies to be fully realised with due consideration for the human dimension.
- Coordinate global interoperability efforts and promote European R&I results in relevant international fora.

It is important to note that issues related to the policy, regulatory and financial framework have to be addressed in parallel and/or factored in so that the initiative is enabled to achieve its objectives and effectively contribute to the relevant EU policies and targets from a broader perspective. This could be addressed by future developments of the regulatory framework and EU aviation relevant policies and strategies.

A monitoring framework will be developed in the context of the European ATM Master Plan maintenance and Work Programme implementation to access progress towards achieving these objectives.

2.2.3 Expected impacts

Scientific impacts

New scientific knowledge and reinforcement of EU scientific capabilities

If successful, the R&I ecosystem established and supported by this initiative would develop and validate new technological and operational ATM solutions that help develop new scientific knowledge and reinforcement of EU scientific capabilities. This impact should start being visible over the medium term and should continue even after the end of the R&I.

The development of ATM solutions would make use of new scientific methods, in particular digital technologies (e.g. big data, automation, AI, virtualisation). This would generate new data, use cases and applications that test and reinforce these technologies.

The planned R&I activities would require and involve a wide range of expertise from various scientific and engineering disciplines, such as aviation and infrastructure engineering, communications, operations research, computer science and thus helps build the cooperation and scientific exchanges between these branches.

Enhanced capacity among the next generation aviation professionals:

The benefits of bringing the ATM infrastructure indo a digital age to users and businesses in the whole aviation value chain (i.e. including aircraft manufacturers and aircraft operators) and the economic growth that could come via their productivity contributions, are compelling[31]. This will not only contribute to a more resilient and sustainable EU economy that create jobs but also help expand the knowledge base and skill sets of academia and company staff.

In order to be able to develop the needed ATM solutions, and to facilitate the best performing ATM in the future, next generation ATM professionals would need to be aware of this science. Apart from performing research, the goal of academia, in general, is to promote knowledge transfer to the next generation of professionals through the involvement of Ph.D. students and post-doctoral students in the R&I research activities. This would enhance the capacity among the next generation of aviation professionals, which would likely have a strong impact on the education of the next generation of experts. This impact would start being evident at the medium term and continue throughout the lifetime of the initiative.

Economic/technological impacts

[31] European ATM Master Plan Edition 2020

An aviation infrastructure that supports the growth and recovery of Europe in a post-COVID world and that opens up digital opportunities for people and business while enhancing Europe's position as a world leader in the digital economy

If successful, the initiative would allow for an accelerated delivery of innovative ATM solutions needed for all types of aircraft operations that help improve the flexibility of the European ATM network and systems. This would allow for the handing of additional flights and thus facilitating growth in the air transport sector.

Safely and efficiently integrating drones and drones traffic management systems with the ATM systems would facilitate the ramp up of drones-related economic activities, opening up the market for new types of drones' services operators and drones traffic management service providers.

Furthermore, a Europe-wide agreed ATM architecture relying on inter-operable ATM solutions standardised and certified at European level would give Europe a strong voice at international level, where European technologies can and should be the backbone of global ATM modernisation plans coordinated by ICAO. This would boost the EU industry globally by enabling international agreements and contracts.

The economic benefits have been evaluated as part of the recent European ATM Master Plan update campaign[32] and assume an effective roll-out of R&I results into operations are summarised in Table 1.

Table 1: Expected economic impacts

Expected impacts	Quantification Method	Value
Ability to handle additional flights in case of growth in air transport	Direct benefits of ATM value chain Cumulative Benefit up to 2050	€510b
Enable new economic activity based on drones	Direct benefits of the U-space value chain Cumulative Benefit up to 2050	€350b
Boost EU industry globally through international agreements and the setting of global standards	Grow market share to 70% of the global market of approximately €4b per annum Cumulative Benefit up to 2050	€84b

Source: Master Plan Companion Document on the Performance Ambitions and Business View. 1.0, SJU, 2019.

To realise these benefits significant investments will be stimulated. As further elaborated in section 3.2 the overall investment requirement to meet this challenge inside the Horizon Europe timeframe is likely to represent EUR 2.9 billion in research & innovation efforts alone, with several times this amount in private sector investment to roll-out the new capabilities across the network (~EUR 40-50 billion for the period from 2021 according to the European ATM Master Plan[33]).

Societal impacts (including environment)

A digital European sky will ensure that passengers do not lose time at airports or in the air in Europe. In doing so, it could save yearly up to 14.5 million hours that passengers will be able to spend instead with their family or at work.

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[32] Master Plan Companion Document on the Performance Ambitions and Business View. 1.0, SESAR, 2019.

[33] European ATM Master Plan, Section 6

If the initiative is successful, and the R&I results implemented, the expected societal impacts would be reduced travel times, improved predictability, reduced delays and lower costs. This would improve both the passenger experience and business opportunities.

Table 2: Societal Impacts

Expected impacts	Quantification Method	Value
Improve passenger experience by reducing travel time, delays and costs	Indirect benefits for passengers and EU citizens. Cumulative Benefit up to 2050	€760 Bn

Source: Master Plan Companion Document on the Performance Ambitions and Business View. 1.0, 2019.

Furthermore a digital European sky could save 28 million CO_2 tonnes per year, which is roughly equivalent to CO_2 produced by 3.2 million people or the population in the metropolitan area of a city like Madrid.

The technological progress resulting from this initiative would ultimately lead to optimising flight trajectories and traffic flow, i.e. planes being able to fly the cheapest, shortest route possible while maintaining the required high safety levels. This would contribute to the long-term goal of reducing aviation noise and gas emissions (i.e. 5-10% less CO_2 emissions per flight by 2035) from an ATM-operational perspective.

Table 3: Expected Environmental Impacts

Expected impacts	Quantification Method	Value
Reducing aviation noise and gas emissions	Reduction of 240 kg to 450 kg of CO_2 on average per flight due to improved flight efficiency Cumulative Benefit in terms of fuel savings up to 2050	€12b

Source: A proposal for the future architecture of the European Airspace, SESAR, 2019.

2.2.4 Collaboration opportunities identified with other Partnership candidates

As the infrastructure is shared but still fragmented across all EU Member States, often used by a wide (and ever widening due the potential offered by drones) range of both civil and military use cases, ATM modernisation should be addressed through close collaboration frameworks with other programmes and initiatives to create synergies and limit duplications. Regarding other initiatives such as (but not limited to) Clean Aviation, it is crucial to share views on the ways to integrate the next generation of aircraft that will be cleaner and quieter and ideally to share a common vision to define where to concentrate efforts. Joint or coordinated calls, including their funding and management, would be the next step to ensure full coherence with other initiative's agendas. As further described in section 3.1, beyond air transport ATM R&I should also ensure that it remains coherent with wider R&I initiatives such as:

a) Digital and Space technologies (for example Key Digital Technologies, Smart Networks and Services, AI, Data and Robotics, Space and Climate Science). In particular ATM needs to be aware of and adapt to the ATM context the evolution of technologies for data manipulation and distribution, cyber security, legal aspects (e.g. on data ownership, responsibility and liability issues) advanced decision making including big data and artificial intelligence.

b) Multi-modal transport (for example the candidate partnership on Transforming Europe's Railway system). In particular the ATM system needs to be aware of performance requirements to support multi-modal transport – the level of predictability to enable through ticketing, and the data exchange requirements to enable luggage reconciliation.

2.2.5 Strategic roadmap

Europe's common vision to replace the current fragmented national systems with a new collaborative platform at EU level is the Digital European Sky defined in the European ATM Master Plan Edition 2020 which was adopted by the SESAR JU Board on 17 December 2020. This document, approved by the entire European aviation community (including EU and Eurocontrol Member States), contains the agreed target vision of a digital European sky as well as the R&I priorities to reach it, the technological roadmaps and the associated critical path. It also highlights the limits of the current programme (focused at delivering R&I up to TRL6 for Phase C) and identifies the additional R&I that needs to be launched quickly to deliver on time to reach the end target of a digital European sky (advancing maturity and market uptake for Phased C and D). One of the key descriptions is to be found in the Figure below, extracted from the Master Plan:

FIGURE 7. FOUR-PHASE APPROACH TO IMPROVEMENTS

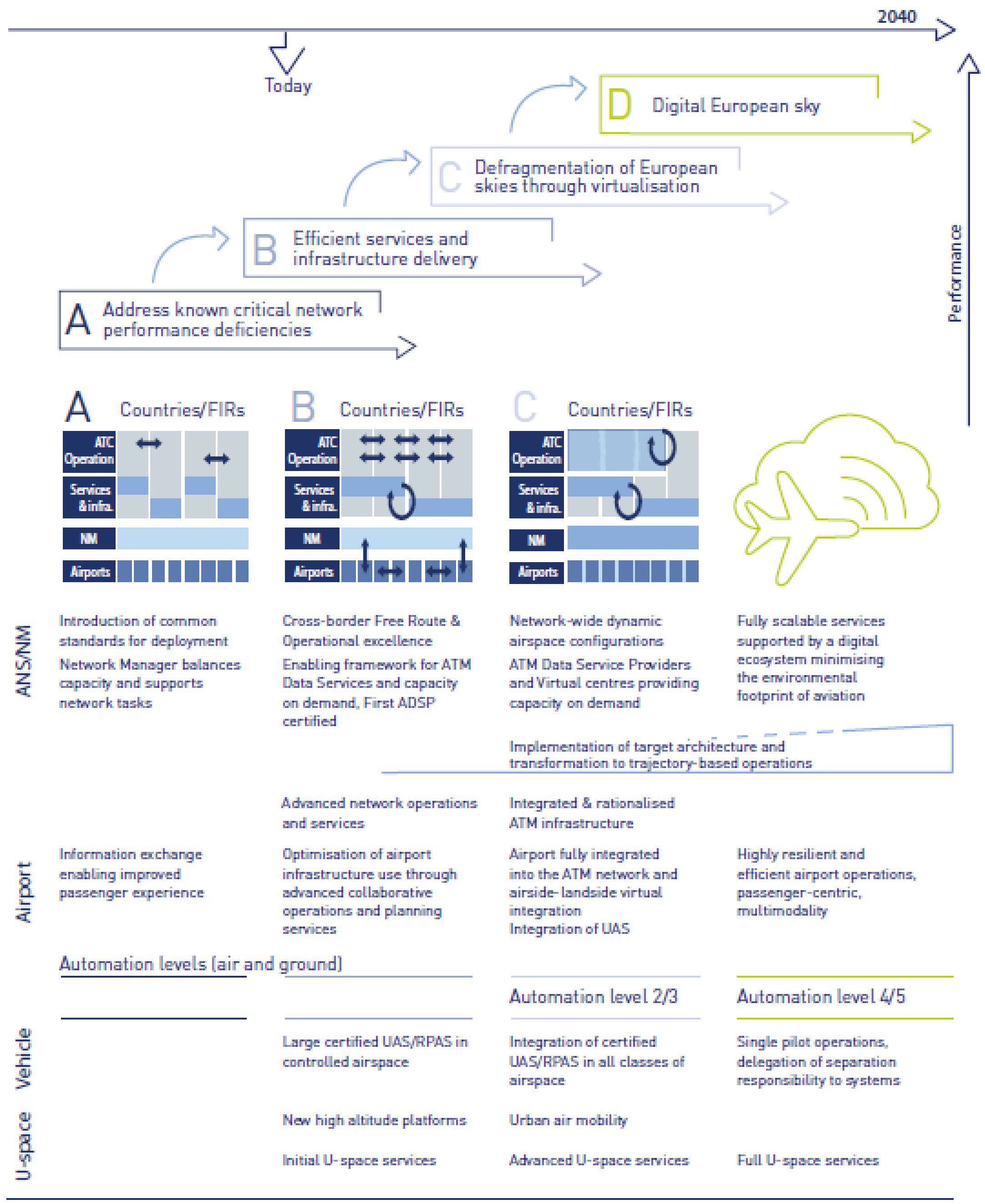

Figure 3 SESAR four-phased approach to R&I

The Master Plan is the basis on which the Strategic Research and Innovation Agenda (SRIA) for the future R&I programme is being built, as it has the support of the ATM stakeholder community and of the Member States. It is critical that stakeholders with strategic roles in the sector remain committed to the partnership. Industry will continue to improve the performance, cost and reliability of solutions. A partnership naturally encourages the cooperation between stakeholders who are otherwise competitors, working together on the basis of a jointly agreed multi-annual plan addressing common goals for the sector.

SRIA process:

A Strategic Research and Innovation Agenda for the partnership (SRIA) is currently being developed by the stakeholders, under the coordination of Eurocontrol, in line with the newly adopted European ATM Master Plan Edition 2020 and this High Level Partnership Proposal.

A public consultation is due to launch in the end of July 2020. It will be followed by a stakeholder workshop in September.

2.3 Necessity for a European Partnership

2.3.1 The necessity of EU action

All identified problems described are currently being addressed at EU level:

- The Single European Sky defines the policy context;
- R&I is coordinated by the SESAR Joint Undertaking and
- Synchronised deployment is ensured through Common Projects.

Recent European Court of Auditors reports[34,35] found that the current policy, R&I and deployment initiatives have generated a change process, but that more efforts are needed in order to realise the full benefits of ATM modernisation: "*It is therefore necessary to accelerate and better focus efforts on transforming the European ATM system into a digital, scalable and resilient network, through an approach coordinated at EU level*".

This can only be achieved by transforming the current patchwork of national systems into a modern collaborative and distributed platform[36], evolving from bespoke, product-based systems to a service, collaborative and adaptable network approach. Achieving an interoperable infrastructure is a prerequisite to unbundling the physical infrastructure from service provision and a fluid and secure access to ATM data. In this way air navigation services will be able to be provided irrespective of their physical location, at any moment and to any part of airspace. This requires significant R&I funding to develop and validate transformative technologies with a high degree of consensus from both Member States and the industry[37].

2.3.2 Priority setting and level of directionality required

Europe's common vision is the Digital European Sky defined in the European ATM Master Plan. The core vision of the Digital European Sly is to replace the current fragmented national systems with a new fully scalable & resilient ATM system with strong air-ground integration that relies on a digital ecosystem. The Master Plan is the basis on which the strategic research and innovation agenda (SRIA) for the future R&I programme will be built, as it has the support of the ATM stakeholder community and of the Member States. It is critical that stakeholders with strategic roles in the sector remain committed to the partnership. Industry should be ready to continue to improve the performance, cost and reliability of solutions. A partnership naturally encourages the cooperation between stakeholders who are otherwise competitors, working together on the basis of a jointly agreed multi-annual plan addressing common goals for the sector.

Less mature solutions should also continue to be supported. Political support from both the Member States and the Union is needed and often the technological solutions (e.g. for safety) are not necessarily economically viable.

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34 Single European Sky: a changed culture but not a single sky, Special Report 18/2018, ECA.

35 The EU's regulation for the modernisation of air traffic management has added value – but the funding was largely unnecessary, Special Report 11/2019, ECA.

36 A proposal for the future architecture of the European airspace, SJU, 2019.

37 Further details on the necessary transformational technologies are provided Annex 6.

To conclude, the level of directionality should be as high as possible for the initiative to reach its expected impacts. The strategic vision should be shared and implemented as much as possible by the key stakeholders along the whole value chain.

2.3.3 How the partnership will establish a meaningful collaboration with Member States and competent authorities

A strong Partnership will ensure long-term coordination between various national initiatives in the sector and also between the public and the private sectors, balancing industrial interests with the coherence and adequate prioritisation of R&I, the long-term EU aviation strategy and the protection of public interest.

The European Union and Eurocontrol would remain the founding members of the new partnership. Their internal processes would ensure that they systematically consult their respective Member States (Single Sky Committee for the European Commission to develop a Union position and Provisional Council for Eurocontrol).

In addition, the future partnership aims to establish a close cooperation with EASA and national authorities both in their advisory and regulatory role on activities related to:

- Advise on research topics in the fields of safety, security, environmental protection and interoperability
- Support on safety and security risk assessment as well as environmental protection
- Contribution to standards development and appropriate certification
- Development of the future regulatory framework to support innovation adoption

Furthermore, a specific “State Representative Group” is proposed to be established allowing the Member States to provide advice on the implementation of the future programme and associated strategic priorities. The Group will also play a role in terms of supporting the future partnership in promoting the programme at national level and in identifying synergies with other relevant EU policy initiatives.

2.3.4 Exit strategy

The Partnership should pave the way for achieving the Digital European Sky vision by 2035. .

The proposed duration for the partnership is until December 2031, when its activities should be winding up. Calls for proposals shall be launched at the latest by 31 December 2027. In duly justified cases, calls for proposals may be launched by 31 December 2028 Once funding from Horizon Europe ends, the partnership shall cease to exist. By that time, the Union, in line with the Framework Programme rules and in consultation with the ATM community shall decide whether there is still a need for coordinated ATM R&I activities in Europe and propose the best way forward.

In the absence of renewal, appropriate measures conditions and timelines ensuring the orderly phasing-out of Horizon Europe funding will be agreed between the partners ex-ante, without prejudice to possible continued transnational funding by national or other Union programmes, and without prejudice to private investment and on-going projects.

2.4 Partner composition and target group

The expected vision, objective and expected impact of the future partnership can only be achieved by compressive and wide coordination with all stakeholders that develop, supply, operate, use and regulate the infrastructure supporting aviation in Europe covering all TRL levels.

A partnership approach would allow establishing a strong coordination with industrial, operational, institutional, national, standardisation & certification actors active at different steps of the SESAR innovation cycle including the SESAR deployment phase.

To that end, the future R&I on integrated ATM should include:

a) Suppliers of “ATM solutions”, i.e. air and ground system manufacturers and ATM data service providers.
b) New entrants particularly active on emerging autonomy and connectivity solutions (such as but not limited to urban air mobility, U-space, mobile network operators).
c) Operators and users of the system namely air navigation service providers, airport operators and airspace users – including both civil and military organisations.
d) The Meteorological community such as MET service providers
e) EASA and national authorities to ensure smooth progress through certification and regulatory processes.
f) EUROCAE and other standardisation bodies to deliver the next generation standards
g) EUROCONTROL (an inter-governmental organisation) as a key actor in European ATM with a large R&I capability and specific operational roles in terms of managing the ATM network.
h) The European Space Agency (ESA) and satellite communication providers as the sector may allow to develop highly innovative solutions for the benefit of aviation
i) Research establishments that mainly perform applied research and are increasingly engaging in supporting the introduction of breakthrough innovation into the market
j) The ATM R&I community of universities and specialist SMEs that currently support exploratory research.
k) The professional staff associations to ensure the involvement of operational staff in the development of new concepts as well as R&D validation activities
l) The wider R&I community that could support the adaptation of new technologies (e.g. digitalisation, earth observation, satellite navigation, climate science, et.) to the ATM context.

Partners would have to be closely associated under the coordination of the partnership (upon a mandate received from the Commission, as it is currently the case with the SESAR JU) in international negotiations and ATM standard setting activities as Europe should continue to have a strong voice at international level, where European technologies should remain the backbone of global ATM modernisation plans coordinated by ICAO.

3 Planned Implementation

3.1 Activities

3.1.1 Digital European sky innovation portfolio

The ATM solutions resulting from the SESAR 2020 R&I programme provide a solid foundation for the future partnership activities. Nevertheless, as stated in previous sections, many of the innovations need to deliver the digital European sky are not "business as usual" but breakthrough solutions that combine digital and physical infrastructure capabilities. This is illustrated in the 2020 European ATM Master Plan (see picture below).

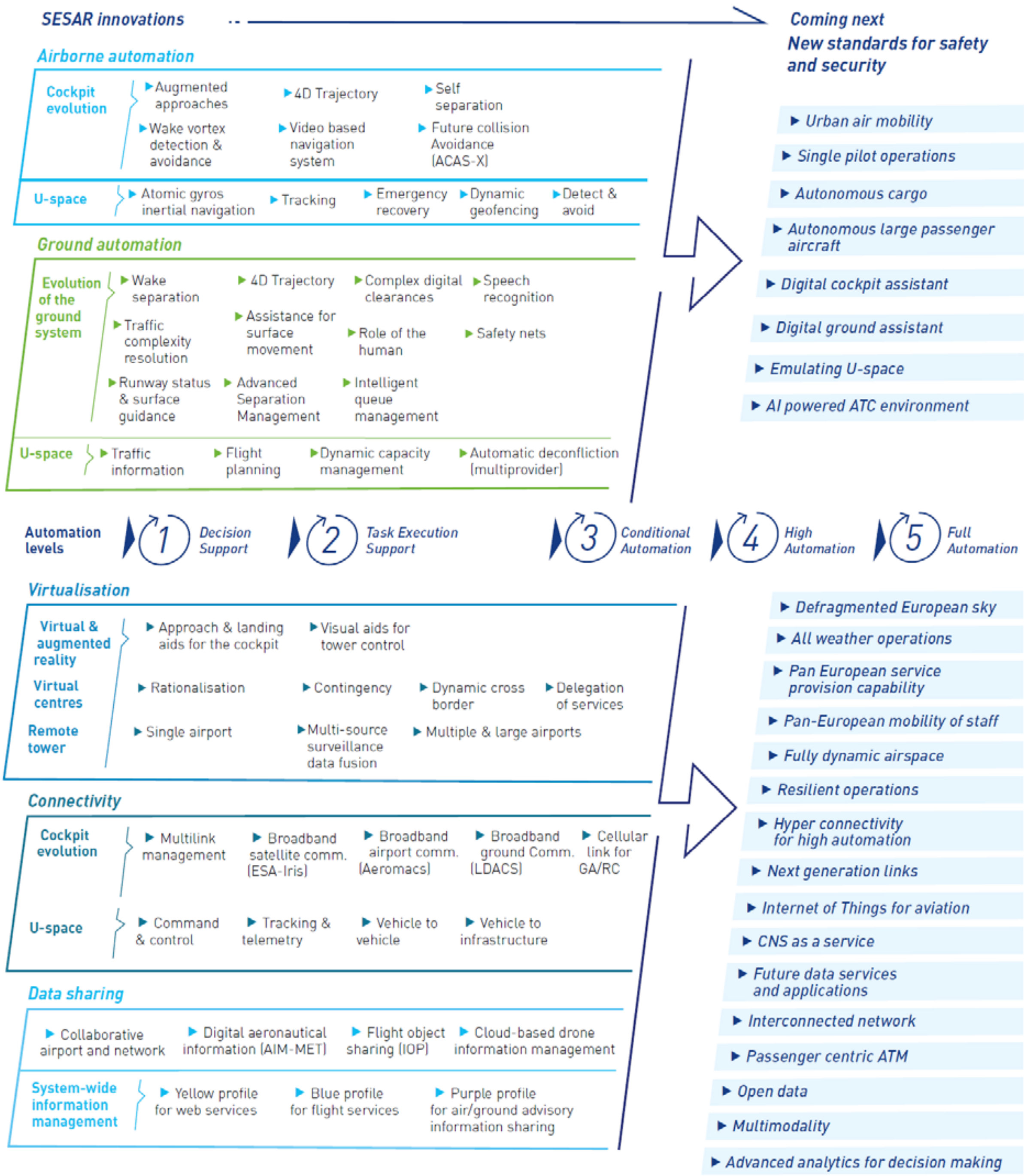


Figure 4 R&I needed after SESAR 2020

To deliver the digital European sky as defined in the European ATM Master Plan the high-level portfolio of research and innovation activities is further described below. These are the future flagships of the programme. They are at this stage described from a transversal perspective and not yet allocated to any of the 3 pillars of the programme (Exploratory Research, Industrial Research and Digital Sky Demonstrators).

The activities undertaken by the partnership will ensure these solutions are safe and cyber-secure "by design". Solutions specifically focused on improving safety and cybersecurity performance, will also be looked at. In close coordination with EASA, close attention to safety and security-related matters will provide greater confidence and efficiency in achieving the goals of the European ATM Master Plan.

Connected and automated ATM The future ATM system will deliver hyper connectivity between all stakeholders (vehicle-to-vehicle, vehicle-to-infrastructure) via high bandwidth, low latency fixed and mobile 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.

Activities in these area will address the following challenges:

- **Automated ATM and the role of human:** Increasing the level of automation in air traffic control is a key enabler for achieving the Digital European Sky**.** Research should explore whether and in what ways automation could be used to deliver substantial and verifiable performance benefits while fully addressing safety concerns. The progress made in the fields of machine learning and AI has opened the door to a myriad of applications in ATM. Many tasks in aviation that today can be performed only by humans can be automated in future, enabling an increase in the safety and scalability of the air traffic system**.**
  Research questions include: How can human and automation form a well-performing team in all situations, even degraded ones, while gaining acceptance in society and by the concerned operators? What are the best transition strategies?
- **Hyper connectivity and Machine to Machine applications**: The digital transformation of aviation will need to be backed up by an increase in the connectivity, capacity, speed and reliability. Different technologies and standards, such as 5G or satellite-based solutions will have to be explored. Hyper connectivity has demonstrated great benefits in a number of domains outside aviation. Similarly in ATM, the challenge is to rely on more performant links between machines (e.g. flying objects, ground based systems, other transport platforms such as rail, maritime). This provides the basis to improve the current operations and enables new business services (e.g. virtualisation, self-separation, autonomous operations). The need to be always connected will become the new standard, both for safety and non-safety critical applications. Research is needed to develop a future concept for digital communications that will make it possible to overcome the current limitations to growth imposed by the limitations of radio/voice communication. While looking at the various operations, services and links this thread will specifically address the safety and cyber-security aspects.
  Research questions include: What will be the next generation data links? How to enable connectivity of all players on the ground in the air and to space (e.g. trajectory and data exchange)? How to enable seamless air/ground automation synchronising frequencies? To what extent new AI techniques (e.g. Speech to Text to confirm good understanding) help improve safety of operations of Air to Air and Air to Ground communication?
- **Infrastructure for all airspace users :** This is about ensuring that infrastructure services will meet network performance objectives and address the aviation

requirements and spectrum constraints as they evolve (e.g. to support future drone operations, and also any other new entrant operations such as Balloons, super-high-altitude operating aircraft, and High Altitude Pseudo Satellites (HAPS)).

Air-ground integration and autonomy The progressive move towards autonomous flying enabled by self-piloting technologies requires a closer integration between vehicle and infrastructure capabilities so that the infrastructure can act as a digital twin of the aircraft.

Activities in these area will address the following challenges:

- **Enabling greater airborne automation and wider performance:** Aerial vehicles will evolve with the emergence of new trends and new vehicles types, such as cargo or passenger drones. The electrification and hybridisation trend will continue to change the aircraft characteristics as well as its operations. U-space unmanned traffic management is expected to demonstrate unprecedented levels of automation that are likely to start making their way into traditional aviation. **S**uper-high-altitude operating aerial vehicles 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 with new characteristics, for example, flying very high or low, very fast or very slow. Their safe and efficient integration into the ATM operation is a challenge. All these different environments will converge towards an integrated ATM in which manned and unmanned aerial vehicles should operate in a seamless and safe environment using common infrastructure and services.
  Moreover, airborne surveillance and the safety nets (terrain, weather, traffic) as well as the evasive manoeuvre will be certainly impacted by the introduction with new actors as drones (UAM, or drone evolving in lower space below 500 ft.).

- **Single Pilot Operations:**
  This envisages a move from current aircraft with two pilots in the cockpit to a single crew in the cockpit, i.e. single pilot operations. SPO is a response to societal expectations on the ultimate capability of a human to remain in the cockpit for strategic decision making.
  Full autonomous flight is an SPO remote use case accounting for the probability of the on-board pilot incapacitation.
  In order to safely operate in reduced crew, safety systems, crew monitoring will be a key enabler to trigger the back-up modes in case of incapacitation, stress or exhaustion of crew members. There is a need to develop a safety critical autonomy platform, an extended high-integrity flight control platform hosting time & safety critical functions, flight control utilities and autonomous back-up mode.
  Research questions include: How to safely integrate into the airspace a large aircraft carrying passengers that is flown with only one pilot, including emergency cases.
  R&I is required to deliver the concept of operations as well as the validated technologies for safe operations (Autonomous decision capability, digital assistant, autonomous control in case of emergency, and interface with ATC for nominal and non-nominal situations).

- **Integration of drones in all classes of airspace (IFR and VFR):** The digital European sky builds on the evolution of ATM towards the integration of large drones, remotely-piloted aircraft systems (RPAS), which will operate safely using ATM services:

manned and unmanned should be able to use the same airport infrastructure; they will both communicate with ATC using datalink; rules and procedures will be applied to both with some adaptations for drones as the pilot is on the ground.
Research questions include: How to enable RPAS to operate in controlled/uncontrolled airspace, both under IFR or VFR, and safely integrate with cooperative and non-cooperative traffic?

Artificial Intelligence (AI) for aviation Tomorrow's aviation infrastructure will be more data-intensive and thanks to the application of machine learning, deep learning and big data analytics we will be able to design an ATM system that is smarter and safer by constantly analysing and learning from the ATM environment.

The "AI for aviation" thread will support the implementation of the European Strategy on Artificial Intelligence and the recommendation of the EC established High-Level Expert Group on Artificial Intelligence (AI HLEG[38]). For the aviation specific aspects, the partnership will aim at addressing the recommendations stemming from the "European Aviation/ATM AI High Level Group" and dealing with research and innovation needs.

Activities in these area will address the following challenges:

- **AI powered ATM environment:** AI uptake should be accelerated. New and emerging AI capabilities will be required for the future ATM /U-space environment. AI based solutions have great potential in improving ATM performance in terms of increased safety, efficiency, capacity and environmental sustainability.
  R&I is required to leverage this technology and investigate ways to reach a trustworthy artificial intelligence in aviation. The partnership will undertake a wide range of measures to accelerate the uptake of this technology while addressing the fundamental challenges associated with it. Safety science will also have to evolve in order to cope with the safety challenges posed by the introduction of machine learning, There is also the need to develop new methodologies for the validation and certification of advanced automation that ensure their transparency, robustness and stability under all conditions. AI being largely dependent on data, the partnership will support the access and sharing of data while looking at data quality, data integrity, ownership, and data governance aspects.
- **Digital cockpit and ground assistants:** AI-powered systems are expected to be integrated into the cockpit and in the ground which would amplify air/ground machine to machine communication for trajectory management and much more. Digital assistants powered by AI to automatically negotiate with the ground and manage any trajectory changes.
  Digital assistants on board hosted in EFB or open-world will request to be also connected to avionic world to ease the data exchanges (i.e. the trajectory computed by the digital assistant on board or on ground should be transmitted automatically to the avionic domain): in this context, the cybersecurity will be a key enabler of these exchanges. This is a first step toward artificial co-pilot necessary for future reduced crew / SPO / autonomous operations.
  Furthermore thanks to permanent high bandwidth connectivity, a lot of data and meta data will be processed on-board to aid pilot decisions: these functions will request a new high performance service platform interfacing the ground (or cloud) open world platform (AOC) and on-board avionics.

[38] https://ec.europa.eu/digital-single-market/en/high-level-expert-group-artificial-intelligence

Research questions include: How to enable ATM performance benefits by developing a digital assistants to Air traffic Controllers and to pilots enabling high levels of automation and efficiency?

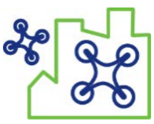
- **AI for better airborne operations :**
  New sensors will be loaded on board (drones and aircraft) as camera, MMW radar, lidar in order to be able to execute news operations (automatic take-off or landing,…). These news operations will request new functions as sensor fusion, vision based navigation, trajectory optimization: these novelties will certainly be based on new multi sensor fusion platform hosting these AI based functions. The application of in this domain and the potential to increase the safety operations is to be investigated.

Capacity-on-demand and dynamic airspace Technology will enable the dynamic reconfiguration and the activation of cross-border capacity-on-demand services to maintain smooth traffic services at busy times.

Activities in these area will address the following challenges:

- **On-Demand Air Traffic Services:** The increasing number of flights and the emerging new technologies will lead to a structural transformation of the way air traffic services are provided. In order to deliver the capacity needed across the network increasing flight efficiency and maintaining safety requires that capacity be optimised "on demand" and in a dynamic, agile and resilient manner. The "Capacity on demand" concept aims at flexibly allocating resources to where they are required due to traffic demand, irrespective of the controller's physical location in Europe taking into account network optimisation needs.

- **ATM continuity of service despite disruption:** In case of disruption, the new architecture should enable solutions allowing for the continuity of service. For example enable resources (including data) to be shared across the network supporting a flexible and seamless civil/military coordination allowing for more scalable and resilient service delivery to all airspace users. The provision of resilient ATM system should continue to provide services despite disruption (capacity bottlenecks, adverse weather, national system breakdowns or social actions).
  Research questions include: How to enable performance driven air transport possible independent of any sort of disruption, for all sorts of flights, to any sort of airport, through any network of airspace?
- **Future data services and applications for airport and network :** This aims at ensuring that airports and other operational sites (e.g. rotorcraft and drones landing sites) will be fully integrated at network level, which will facilitate and optimise airspace user operations in all conditions.



U-space and urban air mobility A digitally native traffic management system will ensure the safe and secure integration of drones in the airspace especially in urban areas, taking into account new and existing air vehicles and autonomous operations. One of the most challenging use cases from U-space will be to enable urban air mobility, which is expected to advance autonomous technologies in a number of areas.

Activities in these area will address the following challenges:

- **Urban Air Mobility:** Urban Air Mobility (UAM) will feature flying taxis operating at low and very low level in suburban and urban areas. Existing vehicles such as

helicopters will move naturally towards more autonomous operations, alternative propulsion and new vehicle designs. There are a number of related projects around the world, some already experimenting with aerial prototypes. UAM will be one of the most demanding use cases for U-space, services of which will need to be validated.
The research question include: How to safely integrate into the airspace flying taxis that could perform autonomous operations with electrical platforms?

- **ATM / U-Space convergence:** U-space unmanned traffic management is expected to demonstrate unprecedented levels of automation that are likely to start making their way into traditional aviation. Drones / U-Space Users and traditional ATM users share the same airspace. The possibility of a fully integrated airspace without segregation between U-Space and ATM must be investigated.
- **Advanced U-space services:** The gradual implementation of U-Space services is materialised through 4 phases (U1, U2, U3, U4) where the final phases (U3 and U4) will enable missions in high density and high complexity areas. The first stages (U1/U2) are already being tested in SESAR 2020 programme. Drones for long distance operations and their integrations in the airspace will have to be also tackled. The same problems (surveillance, safety net, datalink, command and control, Detect And Avoid, ground station,…) should be addressed.
  Moreover, the landing solution for drone will have to be defined and develop to address all weather conditions for which drone operations will be authorized
  Looking forward, new technologies, automated detect and avoid functionalities and more reliable means of communication in will enable a significant increase of operations in all environments and will reinforce interfaces with ATM/ATC and manned aviation.

Virtualisation and cyber-secure data sharing Service provision will be decoupled from the physical infrastructure, enabling air traffic and data service providers, irrespective of national borders, to plug in their operations where needed in a secure manner.

Activities in these area will address the following challenges:

- **Future data sharing service delivery model:** Data sharing will support the progressive shift to a new service delivery model for ATM data, through the establishment of dedicated "ATM data service providers" (ADSPs). The ATM data services would provide the data and applications required to provide air traffic services and include flight data processing functions like flight correlation, trajectory prediction, conflict detection and conflict resolution, and arrival management planning. These services rely on underlying integration services for weather, surveillance and aeronautical information. The maximum scope of service delivery by ADSPs would cover all ATM data services (such as flight data processing) needed to realise the virtual de-fragmentation of European skies and includes the provision of Aeronautical Information Services, Meteorological and Communication, Navigation and Surveillance services.
- **Infrastructure as a Service**: Through a service-based approach, the infrastructure services (e.g. communication, navigation, surveillance) will be specified through contractual relationships between customers and providers with clearly defined European-wide harmonised services and level of quality. This approach will create business opportunities for affordable services with a strong incentive for service providers to compete, the expectation being to secure the provision of safe, efficient and cost-efficient services. Importantly, this will enable the virtualisation of ATM

(consisting in decoupling the provision of ATM data services from ATS) and will allow ANSPs to make implementation choices on how new services are provided.
R&I needs to deliver solutions utilising infrastructure (CNS, IT, U-space…) as a service, enabling new combined services.

- **Virtualisation, scalability and resilience**: With the delivery of services irrespective of the physical infrastructure or the geographical location, the defragmentation of European skies can be realised through virtualisation. Airspace capacity can be offered "on-demand", through horizontal collaboration between air traffic service providers. The digital European sky will allow for more efficient and flexible use of resources, substantially improving safety and cost-efficiency of service provision, delivering the capacity needed and providing efficient services in busy airspace. Virtualisation will also allow the delivery of geographically decoupled services. Ultimately, the virtualisation of air traffic control services will allow the creation of new business models and foster competition in the sector.
- **Open data:** data sharing through interoperable platforms, open data and open architecture policies will allow collaboration between different actors and optimisation of services and process. The sharing of data will allow the improvement and creation of data-based services such as Big Data analytics to enable network optimisation.
- **Cybersecurity**: The increase in the number of connected devices and common standards will lead to an augmentation of vulnerabilities and the possibility of cyber-attacks. The need for new standards addressing safety and cybersecurity is obvious. It will also be necessary to further develop cybersecurity techniques for ATM, including the transfer to ATM of cybersecurity knowledge from other domains (e.g. system design principles, cryptography, block chain, software-defined networking).

Aviation green deal Europe should be the world's most environmentally friendly continent to fly. One of the flagship initiatives of the demonstrator network will be oriented towards accelerating market uptake of solutions enabling "perfect flights" from an emissions perspective, involving the elimination of all possible ATC interferences that would result in a degradation of the optimum trajectory and generate extra emissions. This flagship will also allow the next generation of aircraft, which will be cleaner and quieter, to deliver all their environmental benefits.

Activities in these area will address the following challenges:

- **"Zero waste" trajectories:** Optimisation of ATC actions on flight trajectories (including taxi at the airport) from an environmental perspective and avoiding the degradation of the optimum trajectory.
- **New ways of flying:** This includes the exploration of innovative aircraft operations with positive impact on the environmental footprint (e.g. Automated Formation Flight , geometric altitude instead of barometric (QNH), curved GNSS approaches)
- **Accelerating decarbonisation through operational and business incentivisation:** Optimisation of flight operations (including taxi at the airport) from an environmental perspective in context of a full door to door green mobility

Civil/military interoperability and coordination: Dual-use technologies such as those for communications, navigation and surveillance, and other solutions that allow real-time exchange trajectory information will improve the predictability of military operations and overall network capacity.

In addition to the key areas above further research, activities have been identified.

Multimodality and passenger experience: Citizens expect an increasingly seamless mobility experience, where their "passenger experience" will be smooth, safe and cost-efficient, with minimum delays, transfers and hassle.

Activities in these area will address the following challenges:

- **ATM Role in Intermodal Transport:** Considering ATM as an integrated part of an intermodal transportation system will make it possible to optimise the performance of the overall transportation system and the complete door-to-door journey, instead of optimising the individual modes of transport.
- **Better passenger experience:** Increase the reliability of flight delay information and improve the delivery of such information through better use of big data.

Global harmonisation and interoperability

While developing the above mentioned innovation portfolio, the partnership shares the need for harmonisation as a means of ensuring safe, efficient and seamless global interoperability. It will aim at developing cooperative arrangements with other states and regions of the world as a platform for building cooperation on specific topics of mutual interest, in addition to ensuring alignment with ICAO and ensuring that common standards are available in a timely manner.

3.1.2 Innovation pipeline from exploration to demonstration

The achievement of the digital European sky requires the delivery of a wide range of technological and operational solutions that are currently in various maturity levels.

The strategic research and innovation action will be implemented across the following stages representing the innovation pipeline required to deliver and accelerate the market uptake of research outcomes:

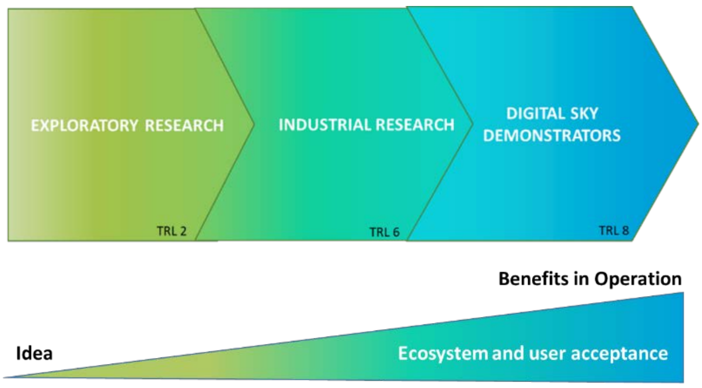


Figure 5 Innovation pipeline

An agile R&I ecosystem (further developed in section 3.1.3) will ensure that upstream research needs and policy objectives are well addressed by the projects and overcoming any unnecessary "silo effects" between e.g. exploratory and industrial research. To that end the innovation pipeline should make it possible to transition more rapidly from exploration (low TRL) to demonstration (high TRL) and the market.

Exploratory research

Exploratory research drives the development and evaluation of innovative or unconventional ideas, concepts, methods and technologies; that can define and deliver the performance required for the next generation of European ATM system. Activities covers low Technology Readiness Level (TRL) research.

This research helps to mature new concepts for ATM beyond those identified in the ATM Master Plan as well as helps mature emerging technologies and methods to the level of maturity required to feed the applied research conducted in the Industrial Research and Validation phase. The target maturity at the end of this phase is TRL 2 and include:

- Pre-TRL1 Scientific Research
- TRL 1 Basic principles observed and reported
- TRL 2 Technology concept and/or application formulated

In order to achieve faster innovation cycles, it would be beneficial to retain all exploratory research and industrial research under the same partnership. Indeed, in order to ensure appropriate knowledge transfer, appropriately consider IPR matters, and contribute to the shortening of the "innovation pipeline", the key resources from exploratory research should inform in a seamless manner subsequent industrial research.

Consortia developing exploratory research usually have a strong academia component. A good portion of students trained on ATM issues come from other fields, working on the postgraduate level research applied in ATM. Keeping exploratory and industrial research under the same structure would allow not losing the ATM related know-how and continue to educate the experts in the field, as is routinely done in the USA, China or Singapore.

Industrial Research

This includes Applied Research, Pre-Industrial Development and Validation. These activities typically start at TRL 3 and result into TRL 6 and include:

- TRL 3 Analytical and experimental critical function and/or characteristic proof-of concept
- TRL 4 Component/subsystem validation in laboratory environment
- TRL 5 System/subsystem/component validation in relevant environment
- TRL 6 System/subsystem model or prototyping demonstration in a relevant end-to end environment (ground or space)

In order to achieve faster innovation cycles, the future programme will reconsider its management approach to be more agile and shift in focus towards the next generation of enabling platforms and their end-user ecosystems. This will stimulate rapid decision and learning cycles, a risk-taking culture and will create buy-in from operational staff.

Accelerating market uptake and aviation green deal through a network of demonstrators

Many of the innovations needed to deliver the digital European sky are not "business as usual", but breakthrough solutions that combine digital and physical infrastructure capabilities. Bringing these innovations to scale–up in the market is challenging considering the high degree of technological, regulatory or market risk the aviation industry faces, which has so far deterred or delayed private investment in its infrastructure.

The establishment of a Europe-wide network of large-scale digital sky demonstrators offers a viable means to build confidence and bridge the so-called "valley of death" between research and implementation. The demonstrators will be closely connected to the standardisation and regulatory framework, and will provide a platform for a critical mass of "early movers" representing minimum 20% of the targeted operating environment to accelerate market uptake. Demonstrators will take place in live operational environments and put to the test the concepts, services and technologies necessary to deliver the digital European sky. This will help create buy-in from the supervisory authorities and operational staff, providing tangible evidence of the performance benefits in terms of environment, capacity, safety, security and affordability. Typically, these activities address up to TRL8. This covers:

- TRL 7 System demonstration in an operational environment (ground, airborne or space): System demonstration in operational environment. System is at or near scale of the operational system, with most functions available for demonstration and test and with EASA proof of concept authorisation if necessary. Well integrated with collateral and ancillary systems, although limited documentation available
- TRL 8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space): End of system development. Fully integrated with operational hardware and software systems, most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios. Verification, Validation (V&V) and Demonstration completed

It is important to stress the difference in scale and impact compared with the demonstrations conducted in SESAR so far. Some of the main characteristics are presented in the illustration below:

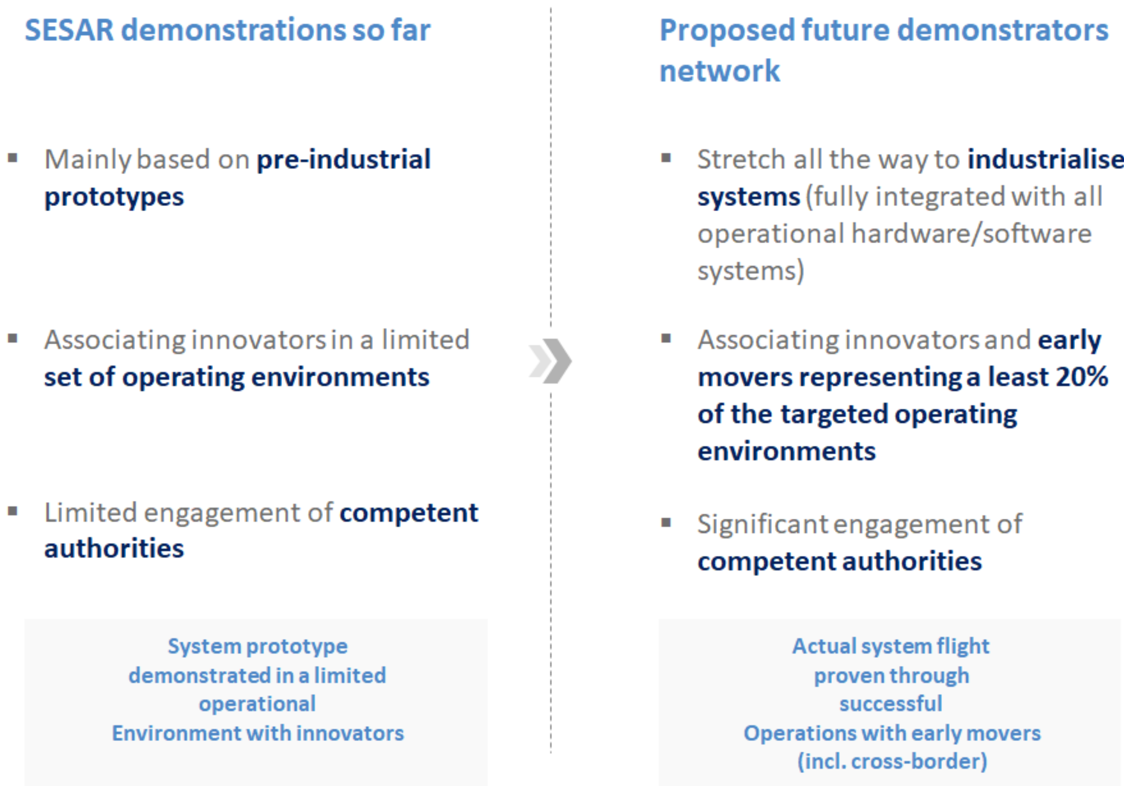


Figure 6 Future vs current demonstrators

In terms of content, due to the underlying maturity of the supporting technologies, in the first years of the Partnership the focus will be placed on the following breakthrough technologies & services (which may at a later stage be expanded based on further R&I progress):

- Virtual Centers & ATM Data Service Providers (ADSPs)
- Dynamic Airspace configurations
- Capacity on demand

- Solutions increasing automation support
- Aviation Green Deal
- U-space & Urban Air Mobility

3.1.3 Developing an agile R&I ecosystem covering the entire ATM & U-space value chain

In addition to coordinating and concentrating all EU R&I activities in ATM, the partnership will act as an innovation platform and bring added value beyond launching R&I calls.

Aviation is a highly regulated and complex market. Without proper guidance, nurturing and business validation, innovations often fail to grow and scale-up. To avoid that, the partnership will put in place a number of measures in order to establish a genuine innovation ecosystem bringing together all the necessary conditions for ground-breaking solutions to reach the market.

This requires the expertise of all stakeholders and the assurance that the technologies developed will meet their needs. Therefore the partnership will unite the whole aviation community, pooling together a wealth of knowledge and experience from a wide variety of fields. Projects will have access to a wide spectrum of aviation professionals (academia, research centres, airborne industry, ground industry, airlines, regulators, air navigation providers, airports, operational and business experts…) providing them with all the necessary guidance in order to reach their full potential.

An integrated approach across the innovation portfolio, will allow for maximising the impact of innovation, identification of interdependencies with other ATM developments, evaluation of risks/opportunities and covering any potential gaps.

To ensure its effectiveness, the partnership should have the following attributes:

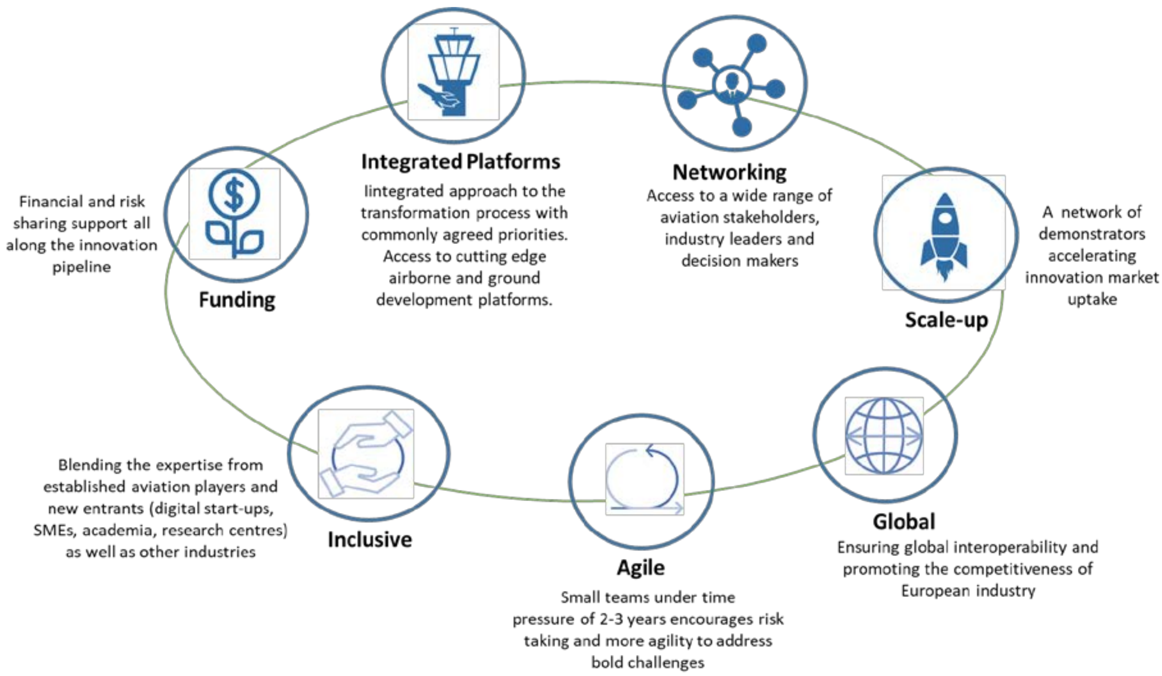


Figure 7 Agile R&I ecosystem

3.1.4 Complementarity with other the European Partnerships

Maximising synergies across Horizon Europe

The proposed partnership will put in place measures to maximise its impact using all possible synergies with other European Partnerships. Beyond the involvement in the overall coordination of Horizon Europe, as illustrated in the figure below, the Integrated Air Traffic management partnerships has specifically identified two types of synergies.

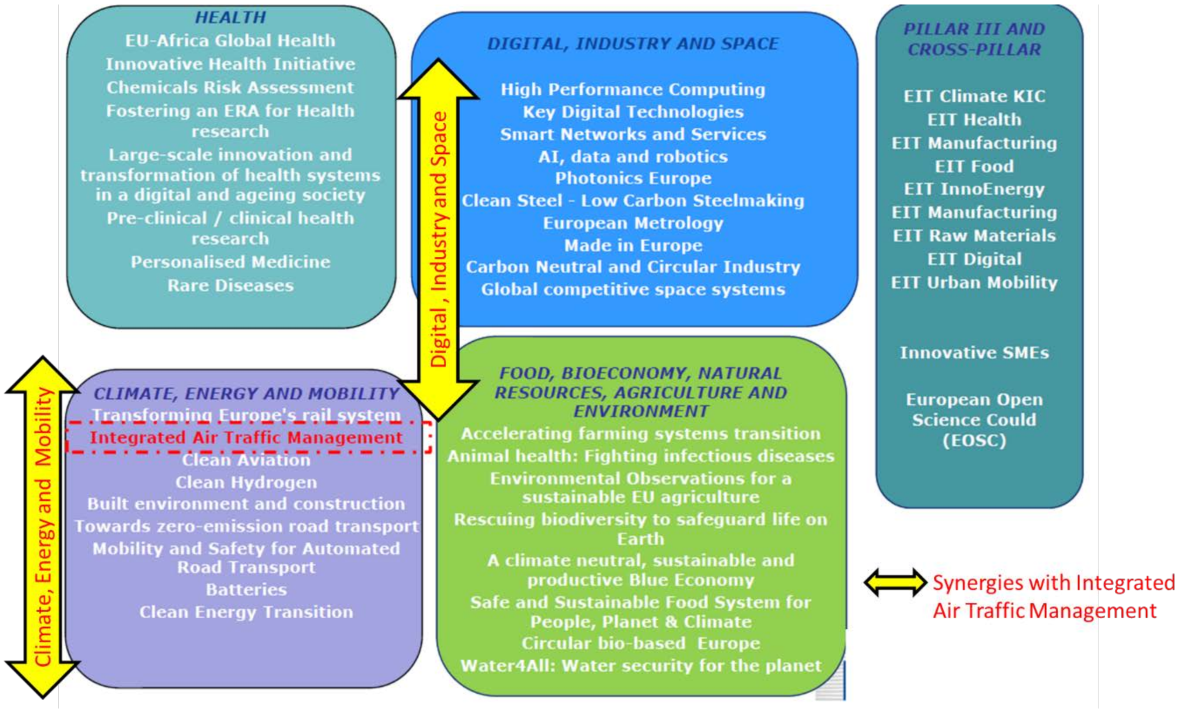


Figure 8 Synergies in Horizon Europe

- **Collaboration within the "Climate, Energy and Mobility" cluster:** In this thread, the partnership will reach out to other mobility solutions with aim to build consolidated roadmaps and action plans for climate neutral mobility solutions. This will also address common sectorial issues such as multi-modality transport, automated vehicles and the decarbonisation of the sector. In particular, a specific coordination with the European Partnership for Clean Aviation is believed to be essential for the aviation sector.
- **Collaboration with the "Digital, Industry and Space" cluster:** Considering that the digital transformation of aviation is at the core of the partnership goals, it strongly echoes the ambition of the "Digital, Industry and Space" cluster. It is in many ways complementing this cluster by addressing aviation critical applications. Therefore is essential to collaborate with all relevant digital initiatives outside the "Climate, Energy and Mobility" cluster. For example artificial intelligence, cyber-security and high performance computing are cross sectorial issues that requires deep coordination especially for the development of use cases and the application European standards. In addition, the partnership 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 to the digital European Sky. Therefore, the partnership will build on the achievement of SESAR 2020 in the space domain to further engage the space actors in the innovation ecosystem.

A coordinated action with the European Partnership for Clean Aviation

The European Partnership for Clean Aviation and the European Partnership for Integrated Air Traffic Management, both proposed under the Horizon Europe programme, will play an essential role to successfully drive the aviation sector to achieve environmental and mobility goals set out by this joint vision for Europe's aviation, while contributing to the objectives of the European Commission. These goals will be attained through the research and development of key innovative technologies for the decarbonisation/energy transition and digital transformation of the aviation area.

Opportunities will be actively sought for running joint demonstration activities. This would enable the two programmes to show in practice the complementarities and synergies between them. It could also allow the programmes to evaluate the combined benefits and impact of particular solutions, in particular for example, the measurement of the aggregated effect of green operations and green aircraft on the achievement of the overall decarbonisation goal. In order to facilitate joint demonstration activities, there will need to be a sufficiently flexible funding framework in place.

A first set of potential areas to demonstrate the synergy effects has been identified (this list is not exhaustive):

- Combined simulations
- Performance and impact assessment
- Autonomous operations
- Airport infrastructure for New Vehicles

The implementation of these joint demonstration activities will be once the two programmes are up and running under Horizon Europe.

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

The partnership will implement all possible synergies in relation to major EU, national (sectorial) policies, programmes and activities. It will aim at leveraging local investments and complement the research and innovation needs by looking at the wider European goals and applications.

For deployment of ATM solutions the partnership will develop synergies with the Connecting Europe Facility Programme. To that end, Member States will be closely associated to discuss priorities and synergies, which is critical to the success of the initiative.

At national level, for example, the future partnership will ensure close coordination with (but not limited to) the following initiatives:

France : Conseil pour la Recherche Aéronautique Civile (CORAC)

For 10 years, CORAC has united all of the players in air transport in France around the ambition to prepare the technologies necessary to improve its environmental footprint and its competitiveness. Airbus A350, LEAP engine, H160 helicopter are some examples of emblematic products embedding technologies resulting from CORAC work.

Its recently unveiled roadmap[39] is characterised by three main topics: energy-efficient aircraft, autonomous and connected aircraft, new development and production methods. It aims to synchronise the efforts of the sector in order to prepare the next generation of aircraft (entry into service: 2025-2030) and aircraft in rupture (entry into service beyond 2030) with new configurations and aircraft intended for new uses such as urban air mobility for example.

[39] https://aerorecherchecorac.com/le-corac-presente-sa-nouvelle-feuille-de-route-a-la-presse-mars-2019/

Germany: Luftfahrtforschungsprogramm (LuFO)

The aviation industry is one of the most research-intensive sectors in the German economy. Research and technology projects that face today's challenges are funded by the Federal Ministry for Economic Affairs and Energy (BMWi). The Aviation Research Program (LuFo) of the BMWi is part of a comprehensive research and technology funding and thus a contribution to supporting competitiveness in Germany.

In terms of content, under LuFO, research and technology projects are funded for the following programme lines[40] :

- Eco-efficient flight: For initiatives and projects of universities to carry out technology research for the 2030 – 2050 application period. The programme line covers all topics and disciplines of the air transportation system and civil aircraft),
- Technology :Funding for industrial research projects can go towards issues like passenger-friendly and eco-efficient cabins, efficient, safe and economical systems, quiet and efficient engines, innovative structures for aircrafts, flight physics, aviation-specific aspects of Industrie 4.0 in development, production and maintenance, and safe, efficient and environmentally compatible aviation processes and flight guidance
- Demonstration: Projects bridging the gap between technology and product development are supported. These include the integration of individual technologies to create a system or a relevant subsystem and the strengthening and development of capabilities and skills at the overall system level.

3.2 Resources

3.2.1 A collective effort for increased ambitions and impact

The ATM Partnership is committed to the objectives set-up in the European ATM Master Plan and to the specific objectives set-out for the partnership. Binding commitments to their contributions will be necessary.

Considering these it is important to note that for the future partnership to meet its objective and have a strong impact on accelerating market uptake with a critical mass of early movers it will require significantly more contributions than in the past.

Indeed, a strengthened partnership that will stretch all the way to coordinating the industrialisation processes with large-scale demonstration activities and ensuring the delivery of technical solutions able to advance smoothly through standardisation and certification processes should be able not only to advance technology readiness but also to stimulate digital aviation infrastructure investments in Member States throughout the duration of the next MFF 2021-2027.

The overall resource requirement to meet this challenge inside the Horizon Europe timeframe is likely to represent EUR 3 billion in research & innovation effort alone, with several times this amount in private sector investment to roll-out the new capabilities across the network (~EUR 40-50 billion for the period from 2021 according to the European ATM Master Plan[41]). To have transformative impact, the Partnership should generate investments of ~ EUR 2.5 to 2.9 billion in research & innovation as illustrated in the chart below.

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[41] European ATM Master Plan, Section 6

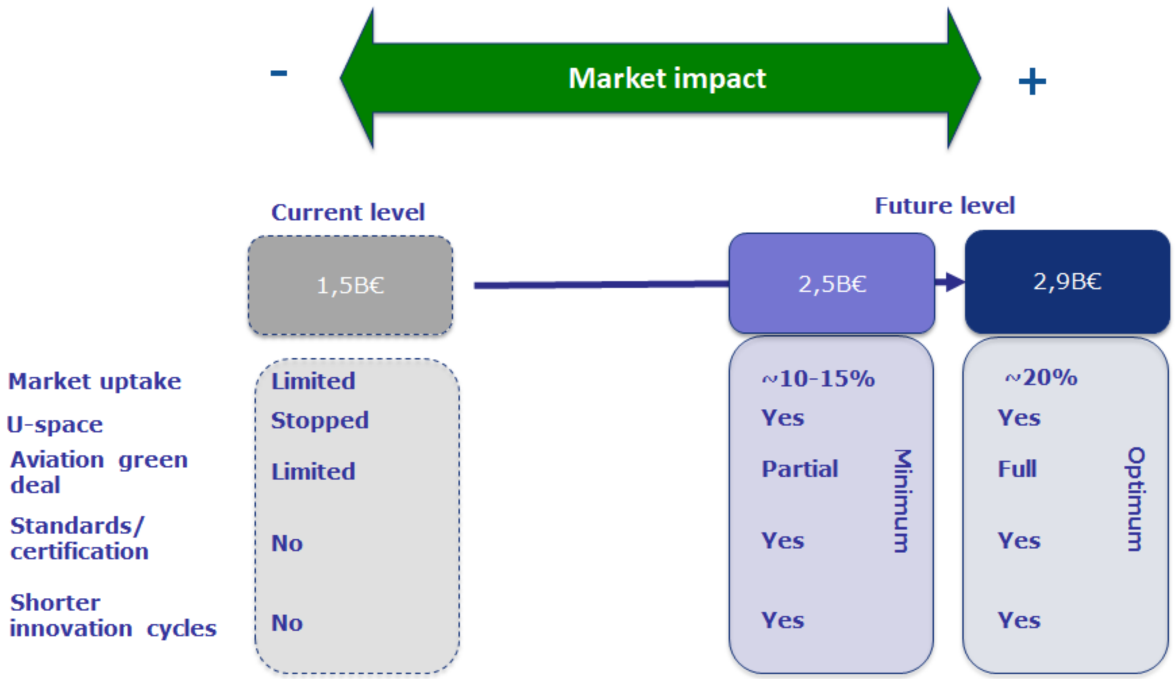

Figure 9 Resource requirements[42][43]

The distribution shown in the table below are orders of magnitude, which will be further refined during the development of the SRIA. It must be noted at this stage that the estimates are only a first approximation. Equally, the allocation between Exploratory Research, Industrial Research and Digital Sky Demonstrators will be a dynamic process with intermittent progress reviews and potential re-orientations (such as the allocation of "Aviation green deal" activities which are currently pre-allocation to the network of demonstrators). It should be possible to have a more agile programme to launch project to advance technologies from e.g. TRL1 to TRL4 more rapidly. To that end, strong front- loading of the programme's funding in the early years of Horizon Europe will be essential. To simplify, the estimates above assume a 100% funding rate for Exploratory Research activities and principally a 50% funding rate for the remaining activities, where however 'non-profit entities' activity will also need 100% funding similar to Exploratory Research efforts. To ensure maximum impact, actual funding rates depending on TRL levels will have to be further agreed and defined based on the key funding principles outlined in the next section.

[42] Current levels (Union EUR 600m, Eurocontrol EUR 500m, industrial partners EUR 400m)

[43] The estimates assume a 50% co-funding rate: 2.5bn - (Union EUR 1bn, industry EUR 1bn, Eurocontrol EUR 500m) and 2.9bn – Union EUR 1.2bn, industry EUR 1.2bn, Eurocontrol EUR 500m. However 'non-profit entities' and Exploratory Research activities would need 100% funding. Actual funding rates will have to be further agreed and defined.

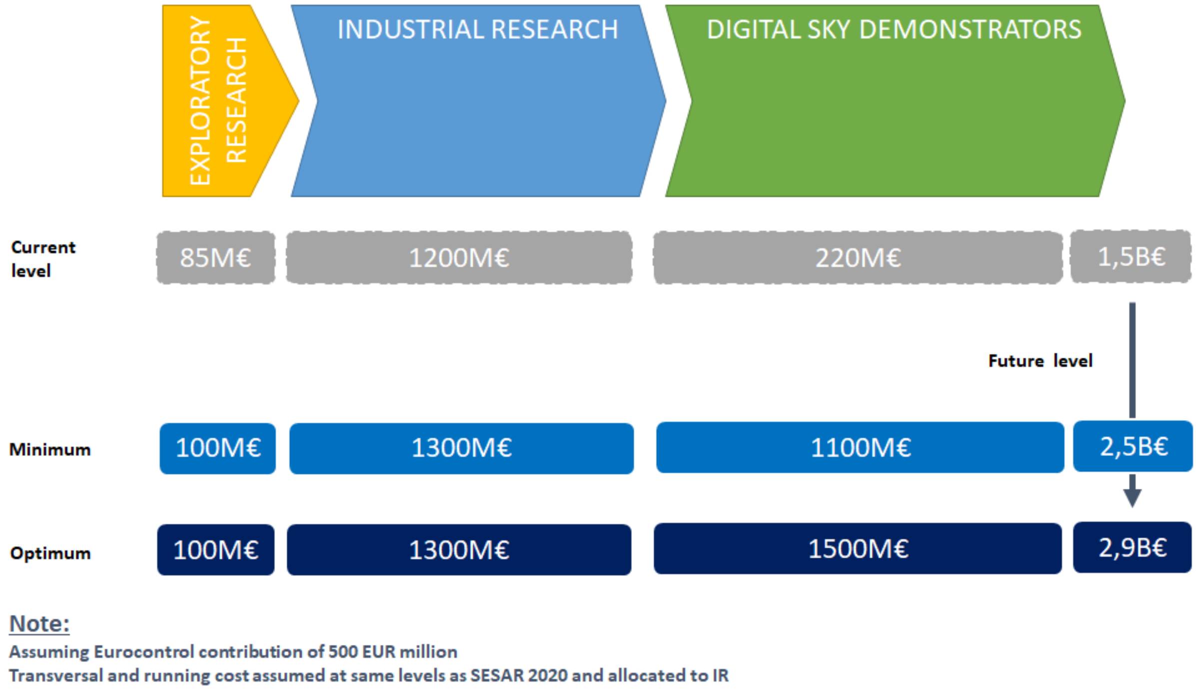

Figure 10 Investment need breakdown

It is estimated that a further research activities will need to be actively connected to the Partnership within Horizon Europe (notably in the domain of transport Clean Aviation but also within the Digital, Industry and Space cluster). The Partnership will act as a Chief 'innovation architect' for aviation infrastructure, ensuring shared roadmaps and cooperating with other European Partnerships, Horizon Europe clusters, and EU programmes, national research and innovation programmes, and leveraging the European Connecting Europe Facility. Combining resources and funding will produce a substantial leverage effect and help reach the challenging objective of climate neutral aviation.

3.2.2 Contributions from partners

Resources contributed by the private side will be:

- In-kind contributions to the projects funded by the Union contributions (on the basis of non-reimbursed eligible costs);
- In-kind contribution for additional activities foreseen in the SRIA/Multi-Annual Work Programme not covered by Union funding;
- Investments in operational activities that is spend beyond the work that is foreseen in the SRIA/Multi-Annual Work Programme;
- In cash contribution used to finance the administrative costs, in case of an Institutionalised European Partnership (Joint Undertaking).

The absolute value of the commitments of the private side as well as in-kind contributions in the Partnership context will be agreed based on the final SRIA/Multi-Annual Work Programme.

3.2.3 Key funding principles to ensure maximum impact

The nature and purpose of the partners' contribution as well as the detailed contribution of Eurocontrol to the partnership will be defined at a later stage, in line with the overall policy. That said, the following principles should be considered when developing the future framework for partner's contributions:

- The conditions for access to funds and associated funding rates should be calibrated so that they effectively help to remove obstacles to innovation and make it easier for the public and private sectors to work together in contributing to shortening the innovation cycles and market uptake on breakthrough technologies. To that end it would seem preferable to work with gradually reduced funding rates, with the funding rate depending on TRL levels covered, from 100% for TRLs 1-2, down to e.g. 40% for demonstrator projects. Furthermore specific conditions for the future Digital Sky demonstrators should be taken into account as these type of activities will most often require to install new equipment both on the ground (e.g. upgrade of the capabilities of air traffic control centres) and in the air (e.g. equipage of aircraft).
- It is acknowledged that the calls funded under the Partnership will be open. However, if during implementation there is a clearly justified need to address specific topics related to market, regulatory or societal uptake with/ including specific partners, then it should be possible to limit participation/funding at the level of individual call topics.
- The detailed contribution of Eurocontrol to the partnership will be defined in the regulation and in a bilateral agreement between the partnership and Eurocontrol at a later stage.
- The conditions should be sufficiently attractive and agile to allow SMEs, start-ups and research institutes to effectively contribute to the future partnership. To that end the future partnership is willing to be a test bed for innovative grant mechanism in the context of Horizon Europe.
- Resources to ensure adequate engagement of EASA and Standardisation bodies should be foreseen to ensure an effective coordination of the industrialisation processes.
- To reduce the administrative burden, reporting should be simplified to the greatest extent possible.

3.3 Governance

The following should be considered in addition to the current arrangements:

- New entrants to be fully integrated (in particular emerging key actors on autonomy & connectivity)
- Stronger engagement of operational stakeholders in running the future network of demonstrators (in particular civil and military airspace users, air navigation service providers and airport operators)
- Engagement of the Network Manager, EASA and standardisation bodies to be strengthened
- Close engagement of Member States & competent authorities

It is proposed that the governance of the future partnership would be, in principle, be designed as follows:

- Governing Board

    - It should be the main governance body of the partnership. It should have overall responsibility for the strategic orientation, including collaboration and synergies with other initiatives, and effective operation of the partnership, should supervise the implementation of its activities in accordance with its Statutes and efficiently manage any potential situation or risk of conflict of interest arising in the implementation of the programme.
    - It should be chaired by the European Commission, representing the EU, with the EUROCONTROL representative as Vice Chairperson and constituted by a

representative from each Member of the partnership, Civil Airspace Users and observers representing the wider stakeholder community (EASA, EUROCAE, the European Defence Agency representing the military, Drone operators, ANSPs, equipment manufacturers, Airports, ATM Staff and the scientific institutions/community).

- 4 supporting advisory committees are proposed:

    - **Scientific Committee** to provide advice on the scientific agenda for ATM composed of scientists and researchers from across the research community and a representative from each of the Founding Members including EASA.

    - **Programme Committee** to provide advice related to the delivery of the work programme: the Programme Committee should be composed of representatives of each of the Members of the partnership including the Founding Members and EASA. In addition to this, there should be one representative of civil Airspace Users and one of Drone community as permanent observers.

    - **Master Planning & Market Uptake Committee** to provide advice related to the execution of the European ATM Master Plan as well as the network of digital European sky demonstrators. This Committee (MMC) is composed of representatives of the European Commission, EUROCONTROL, civil users of airspace, drone operators, the European Defence Agency (EDA) representing the military, ANSPs, air and ground equipment manufacturers, airports, professional staff organisations in the air traffic management sector, EASA, the European Organisation for Civil Aviation Equipment (EUROCAE) and the Network Manager.

    - **State Representative Group** allowing the Member States to provide advice on the implementation of the future programme and associated strategic priorities. The Group will also play a role in terms of supporting the future partnership in promoting the programme at national level and in identifying synergies with other relevant EU policy initiatives. All Member States will be invited to participate in this SRG. Within the SRG the (updates of) the European ATM Master Plan or SRIA and research proposals from industry will be aligned with national priorities, policies and programmes. This is seen as a crucial step in the process of setting priorities, and will facilitate approval of the R&I priorities in the Transport Programme Committee. In addition, it will facilitate the development and approval of necessary policies and regulations in the Single European Sky Committee as well as EASA's regulatory bodies.

Involvement of the Commission

- The Board would be chaired by the Director General of DG MOVE, who is the lead service responsible for policy making on aviation/ATM
- A representative of DG R&I would attend as observer
- For critical Decisions taken by the Board, such as the annual Single Programming Document or the revision of the Master Plan, the College of Commissioners would have to approve the Commissions' position/vote in the Board

- For other non-critical Decisions, DG MOVE coordinates an inter-service consultation involving DGs R&I, HR, BUDG, SG, LS, DEFIS, CNECT, CLIMA to establish the Commission's position

3.4 Openness and transparency

3.4.1 General

The Partnership should ensure an open approach by opening up the innovation process to the greatest extent possible (including people with experience in fields other than incumbent aviation players). This also includes involving new actors (e.g. SMEs/start-ups) across Europe in the innovation process to ensure that knowledge circulates more freely and to develop products and services that can create new markets (disruptive solutions).

Through the network of demonstrators, the partnership should become a forum to share knowledge on how to accelerate the transition towards a Digital European Sky that fully leverages modern technologies. Using industrialised platforms (integrated with operational systems) of the early movers will help to strengthen the evidence for the business case and is expected to increase the buy-in from the community, sparking the interest of stakeholders that were not involved in the earlier R&I. Thanks to this measure, all players including regulatory authorities can mutually learn and exchange practical expertise related to the introduction of the next generation of SESAR technologies. Synergies with the newly established airspace re-configuration and operational excellence programmes will also be sought.

The Partnership should also be open to the world by promoting international cooperation in a domain dominated in other regions by institutional players (such as NASA in the USA, JAXA in Japan etc.) to allow Europe to access the latest knowledge worldwide, recruit the best talent, tackle global challenges and create business opportunities for European industry in emerging markets.

In the next MFF the Partnership (by advancing the maturity of the next generation innovations all the way to market uptake) will be measured against the delivery of the associated next generation standards which will be approved and published by European and Global standardization bodies following an open and well documented process.

3.4.2 Participation

From a resource implementation perspective, the Partnership as a general principle will provide financial support mainly in the form of grants to research actions selected following open and competitive calls, unless otherwise specified in the Annual Work Programme. It will ensure a broad and wide participation by the stakeholders. A mechanism will be established by the partnership in order to allow where relevant access to results and connect the lower TRL projects having a potential for possible uptake in the demonstrators' part of the programme.

It is the aim of the partners to play a key role in the activities of the partnership for actions related to demonstrations (high TRL levels). For this purpose, it is proposed that in duly justified cases conditions in open calls can be set to ensure the involvement of the operational stakeholders and thereby to accelerate the take-up of results (these would be decided case-by-case and specified in the Annual Work Programme);

The calls should be flexible mechanisms to allow other partners/contributors to enter the partnership and contribute to the core activities based on capabilities needed as well as programme priorities and possible evolution. In addition, the grant agreement framework should be flexible in terms of duration, budget allocation and composition of its core partnerships.

3.4.3 Access to information

The partnership will apply in terms of dissemination of results and access to projects results an "open access" policy and "open access to research data" policy to any possible extent depending on the nature of the topics and the TRL of the activities being performed in the partnership in line with the principles and provisions of Horizon Europe. Furthermore, building on the well-established and internationally-recognised SESAR brand, the partnership will develop a comprehensive communications plan to raise awareness and promote the partnership's new research agenda, projects, results, and benefits among key target audiences. The plan will be the basis for developing the following:

- **Revamped visual identity**, building on the established SESAR brand but adapted to reflect the objectives of the new partnership. The visual identity will be applied to graphics, templates and other communication material to be used by members and partners when promoting the partnership and its work.
- **Website** content, detailing the research agenda, membership, projects, procurement updates, events, news, and testimonials from beneficiaries and stakeholders. The website will also give access to all results and deliverables (SESAR solutions) from projects once completed, and provide a means to receive feedback on the work of the partnership and its impact.
- **A calendar of conferences and workshops** to stimulate engagement among partnership membership, project consortia, the wider aviation stakeholder community and institutional bodies. The format and content of the events will be adapted according to the desired target audiences.
- **Social media and digital** content to raise awareness about the partnership and to engage with audiences (both established and new). The partnership will leverage member and partners respective channels and followers to maximise the impact of its social media activities.
- **Publications and newsletters**, featuring regular updates on the partnership's work (including project results and delivered solutions), calls for participation, events, and important policy developments.

3.4.4 Pro-active participation stimulation policy

The Partnership will pro-actively stimulate new participation by analysing the evolving aviation infrastructure ecosystem and the representation of relevant end-users with a particular focus on innovators and potential early movers to facilitate market uptake. Participation of SMEs and start-ups will be stimulated for example through collaboration with the European Aerospace Cluster and their national and regional branch organisations as well the participation of the partnership to the European start-up prize for Mobility under the patronage of the European Parliament.

Appendix I Current composition of the Partnership

The current SESAR JU Members and their respective constituent entities are listed below:

Name of Member	Constituent Entities	Country
The European Union, represented by the European Commission (Founding Member)		
EUROCONTROL, the European Organisation for the Safety of Air Navigation, represented by its Agency (Founding Member)	Single Entity	
Airbus SAS	Single Entity	FR
AT-One Consortium	Deutsches Zentrum für Luft-und Raumfahrt e. V. (German Aerospace Center, DLR)	DE
	Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (National Aerospace Centre, NLR)	NL
B4 Consortium	POLSKA AGENCJA ŻEGLUGI POWIETRZNEJ, the Polish Air Navigation Services Agency: (PANSA)	PL
	RIZENI LETOVEHO PROVOZU CESKE REPUBLIKY STATNI PODNIK, the Air Navigation Services of the Czech Republic: (ANS CR)	CZ
	Letové prevádzkové služby Slovenskej republiky, štátny podnik: (LPS SR s.p.) – State owned ANSP of Slovakia	SK
	Valstybes imone 'Oro navigacija', the State Enterprise 'Oro Navigacija' (ON) – State owned ANSP of Lithuania	LT
COOPANS Consortium	Naviair	DK
	Irish Aviation Authority: (IAA)	IE
	Croatia Control, Croatian Air Navigation Services ltd: (CCL)	HR
	Austro Control Österreichische Gesellschaft für Zivilluftfahrt mbH: (ACG)	AT
	Luftfartsverket: (LFV)	SE
Dassault Aviation SA	Single Entity	FR
DFS Deutsche Flugsicherung GmbH: (DFS)	Single Entity	DE
République Française, Ministère de L'écologie, du Développement Durable, et de L'Energie, acting via Direction Générale de L'Aviation civile, represented by Direction des Services de la Navigation Aérienne: (DSNA)	Single Entity	FR
ENAV S.p.A	Single Entity	IT
Entidad Pública Empresarial ENAIRE	Single Entity	ES
Leonardo	Single Entity	IT
Frequentis SESAR Partners (Consortium)	Frequentis AG	AT
	Hungarocontrol Zrt (HC)	HU
	Atos Belgium SA/NV	BE
Honeywell Aerospace SAS	Single Entity	FR

INDRA Sistemas, S.A.	Single Entity	ES
NATS (En Route) Plc	Single Entity	UK
North European ATM Industry Group NATMIG Consortium	Stiftelsen SINTEF	NO
	Saab AB	SE
	Airtel ATN Ltd.	IE
SESAR European Airports Consortium (SEAC 2020)	Heathrow Airport Limited	UK
	Aéroports de Paris S.A.	FR
	Flughafen München GmbH	DE
	Flughafen Zürich AG	CH
	Schiphol Nederland B.V.	NL
	Swedavia AB	SE
	Avinor AS	NO
Skyguide, Swiss civil and military Air Navigation Services Ltd	Single Entity	CH
Thales Air Systems SAS	Single Entity	FR
Thales Avionics SAS	Single Entity	FR