



The Single European Sky SES2+ – quo vadis?

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Network Industries Quarterly, Vol. 27, Issue 1 The Single European Sky SES2+ – quo vadis?

The first Single European Sky package (SES1) was adopted in 2004 with the aim of addressing the fragmentation of European airspace. It was followed in 2009 by the second Single European Sky package (SES2), which had a new focus on the performance of air navigation services providers (ANSPs). 15 years later, the EU proceeded to a recast in the form of an SES2+ Regulation. In this, the Commission enshrined both its performance-based approach and a parallel approach focusing on Europe-wide network functions, not least because digitalisation had given rise to new technological possibilities. This issue of Network Industries Quarterly aims to untangle the SES2+ Regulation and assess its potential for moving forward.

In her contribution entitled 'Shaping the future of European ATM: lessons from a decade of deployment,' Mariagrazia La Piscopia sets the context for the deployment of SES technological innovation. Tânia Simões Cardoso, in her article entitled 'Modernising Europe's Air Traffic Management System: The Future of Innovation and the Role of EUROCONTROL,' situates technological changes in ATM in the larger context of the transformation of the European aviation system. In a third contribution entitled 'A mindset dedicated to the evolving aviation imperative to harness SES 2+,' Achim Baumann assesses the SES2+ Regulation from the perspective of airspace users. Two articles follow from the ANSP perspective, authored by Ivan Arnold and Daniel Ivan (entitled 'Network governance and the law: How to govern the execution of Network Functions?') and Ivan Arnold (entitled 'The New Service Delivery Model in the Single European Sky: a paradigm-shift in Air Traffic Management?'). In his contribution, 'The art of modernising European air traffic management,' Andreas Boschen explains the needs to both master technology and adapt to transforming frameworks. In his concluding contribution entitled 'European ATM in a pivotal moment,' Matthias Finger situates SES2+ in the broader historical context of the SES project and vision.

Editor of this issue: Matthias Finger

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Shaping the future of European ATM: lessons from a decade of deployment

Mariagrazia La Piscopia, Executive Director of the SESAR Deployment Manager

A period of resilient industry growth

In the last twenty years the European aviation and air traffic management sectors have experienced a period marked by overall significant and resilient growth, but they also lived through a decade of change.

Despite the extraordinary crisis linked to the Covid-19 pandemic and the resulting traffic halt in 2020, and the subsequent gradual recovery, all metrics and indicators show flourishing and successful growth of the sector: the number of flights operated across the European airspace increased by around 20-22%¹ compared to the mid-2000s, and the numbers of passengers in European airports more than tripled in the same timeframe.²

This growth occurred despite notable and sometimes unprecedented external constraints. Air traffic demand in Europe was only temporarily affected by the outcomes of the 2008-2009 financial crisis, as the aviation industry recovered quickly in the subsequent decade with annual growth rates that outpaced the slower and uncertain EU-wide economic upturn.

The resilience of the sector was most visible during the Covid-19 crisis. This crisis put the industry under exceptional pressure, both during its peak in the spring of 2020 – with flight numbers almost instantly dropping by 85-90% in a few months – and in its immediate aftermath, when traffic returned to record-level heights faster than expected, overcoming the negative effects of high inflation rates and labour shortages in 2021 and 2022.

From 2022 onwards, the sector was also grappling with the effects of evolving geopolitical scenarios. The war in Ukraine, with the consequent closure to commercial operations of almost 20% of the European airspace, the resulting changes in intercontinental traffic flows, the unexpected traffic peaks in eastern countries and some western ones, the increasing need to incorporate the military dimension in ATM operations – all these factors resulted

in new constraints, requirements and pressures to be accommodated in the daily management of air traffic.

A decade of technological transformation, supported by SESAR

This resilience was not accidental. It was underpinned by a transformation of Europe's ATM infrastructure and operational concepts. In particular, the last 10 years have been crucial as they have seen large-scale adoption of technologies, procedures and operational concepts that were essential to cope with growing traffic volumes and the associated complexity.

From on-board aircraft equipment to the systems in use in European airports, from the flight planning systems used by airlines to the tools used daily by both civil and military air traffic controllers, despite its safety-oriented traditionally slow-paced and risk-adverse inherent nature, the operational environment of 2025 had evolved from that in use just a decade ago. This clearly underlines the technological primacy of Europe vis-à-vis other regions of the world.

This was mostly due to the joint efforts of operational stakeholders and industry manufacturers, which were coordinated by the Single European Sky ATM Research (SESAR) project. As a set of independent studies and evaluations³ have recently demonstrated, the SESAR initiative has reaped measurable rewards and – since the start of its deployment phase in 2014 – has accelerated its pace and borne its expected fruits more sustainably.

Thanks to a combination of legal instruments, the availability of EU co-funding support from the Connecting Europe Facility, and the establishment of a deployment coordination function⁴ to support the synchronisation of investments, ATM modernisation has seen a change in pace across Europe. This has been particularly visible in technological elements mandated for deployment by

¹ From 9.2 million IFR flights in 2005 to over 11.2 million in 2025 (source: EUROCONTROL).

² Passenger traffic in European airports reached over 2.6 billion people in 2026, a critical increase from the 700 million passengers in 2005 (source: ACI Europe).

³ See for instance the Study on the Current and Possible Future Frameworks for the Air Traffic Management (ATM) Innovation Cycle, 10 October 2025 executed by ALG and Transport & Mobility Leuven, contracted by Rambold and funded by the EC.

⁴ Reg. (EU) 409/2013 on the definition of common projects, the establishment of governance and the identification of incentives supporting the implementation of the European ATM Master Plan.

Common Project 1 (CP1),⁵ a comprehensive EU regulation requiring mandatory implementation by the end of 2027 of a set of critical technologies developed in SESAR R&D activities.

The aim of the regulation is to help build the adequate capacity, safety and operational efficiency needed to accommodate the expected growing traffic demand. The deployment rate of the related technological elements so far has shown the success of the proposed approach. Almost the entirety of the scope of CP1 – composed of six different and wide-ranging ATM functionalities – is currently being effectively deployed, with around 50% in operational use. Half of the different sub-sets of functionalities mandated by the regulation are deployed in all the EU member states or almost all of them (i.e. above 90%).

The list of technologies entered in operation in the last decade includes key operational concepts essential to mitigate the effects of network congestion and increasing traffic demand and to improve the experience of passengers. These include elements such as airport operation plans, departure management, free route airspace, network collaborative management, traffic complexity tools and flexible use of airspace. The latter – which enables unprecedented flexibility to balance the needs of both civil and military airspace users – has proven of particular relevance in eastern Europe with the Ukrainian crisis, allowing the system to adjust to abrupt closures of over 600,000 square kilometres of airspace.

The tangible benefits of SESAR deployment

The synchronised deployment of these technologies across the EU was not merely aimed at supporting regulatory compliance and harmonisation among the EU member states but it was truly instrumental in providing the European aviation industry with tangible and clearly measured operational benefits.

A recently published analysis by the SESAR Deployment Manager⁶ highlights the operational benefits linked to the deployment of CP1 between 2014 and 2024. They go beyond €6 billion, doubling the associated invest-

ments undertaken by ANSPs, airlines, airports and the network manager in the same period (around €3 bn).

These benefits – which are the monetary translation of the mitigation of passenger delays by increasing airspace and airport capacity, the technologically enabled reduction of fuel consumption and CO₂ emissions, and savings in the provision of air navigation services – are only the initial steps in the overall contribution of CP1 to ATM performance improvements, as 2024 marked the commencement of the climb-up phase of operational benefits. In the next few years, operational benefits are set to soar up to savings of €19 billion by 2030, further increasing to €52 billion by 2040.

As a clearly identifiable example of CP1-related benefits, recent analyses jointly conducted by SDM and the network manager have measured the degradation of performances that would have occurred without CP1 technologies in place, particularly regarding ATFM capacity. It is calculated that without CP1 the average en route ATFM per flight in 2024 would have been around 4.18 minutes, almost double the actual 2.13 figure and putting airlines – particularly ones operating a hub-and-spoke model – under further pressure, thus forcing disruptions and cancellations. The analyses also confirm similar improvements at the airport level, with CP1 enabling around 15% of all additional taxi-out time savings achieved in the post-Covid 19 era.

The industry has also demonstrated that coordinated deployment supported by EU funding delivers measurable value. ATM modernisation has shown an exceptional degree of multi-stakeholder, cross-border coordination and – more importantly – a remarkable benefit cost ratio (BCR). The BCR, an indicator comparing the present value of benefits to costs incurred, reached an impressive 5.9 for all CP1-related investments, almost six times the minimum threshold typically used by EU institutions to evaluate flagship infrastructure projects.

Furthermore, the BCR of investments funded by the Union and directly coordinated by the SDM is as much as 6.7, showcasing the positive impact of EU funding in accelerating ATM modernisation in a value-driven manner. To make this clearer, every €1 of co-funding provided by the Connecting Europe Facility for CP1 deployment will translate into almost €14 of operational benefits for the industry.

⁵ Reg. (EU) 2021/116 on the establishment of Common Project One supporting the implementation of the European ATM Master Plan [...], repealing Reg. (EU) 716/2014 on the establishment of the Pilot Common Project supporting the implementation of the European ATM Master Plan.

⁶ A decade of SESAR coordinated deployment: 2014-2024, available at www.sesardeploymentmanager.eu/publications

Persisting shortcomings and future challenges to be addressed

As the data above show, resources put in place by both ATM stakeholders and the European Union in support of ATM modernisation led to significant benefits, and the specific partnership approach established has had beneficial effects.

Nevertheless, the project to build an ATM industry which is fit for the future and meets the needs of European stakeholders and passengers is far from over and shortcomings still remain. As is also highlighted in the latest edition of the ATM Master Plan,⁷ the investments and joint commitment of operational stakeholders would need to be scaled up and massively accelerated in the future to overcome current and future challenges.

Despite the progress achieved, structural limitations persist, combined with newly emerging – yet decisive – challenges:

Capacity remains fragile: the system continues to generate systemic delays and unnecessary inefficiencies, particularly when capacity imbalances emerge during peak seasons. Demand is still growing and – despite recent improvements – the system will soon not be able to satisfy it in the medium-to-long term, particularly in certain European regions. This also includes certain elements of Common Project 1 (such as SWIM and Initial Trajectory Information Sharing), in which the pace of deployment has sometimes failed to meet the expected deployment speed;

Uneven technological uptake: the technological uptake of SESAR has remained slower than expected in certain areas, particularly for elements that were not subject to *ad hoc* EU-wide coordination or were not included in Common Projects, with detrimental effects on the performance of the system;

Industrialisation bottlenecks: uncoordinated, ineffective and laborious industrialisation activities have often slowed down and hindered adequate market uptake of pre-operationally validated elements (i.e. concepts and technologies that have achieved technological maturity), resulting in delays in the launch of wide deployment;

Limited scalability: the management of the Covid-19 crisis and the associated volatility of traffic – despite being successfully overcome in the medium term – demonstrated the limitations – in terms of flexibility and scalability – of the current system, and the negative effects that similar disruptions could have;

Geopolitical pressures: the rapidly evolving geopolitical environment along with the need to swiftly integrate military requirements in daily operations require enhanced civil-military coordination mechanisms and a different approach to ATM operations, with resilience, redundancy and protection against external threats taking more central roles.

Supporting the evolution of ATM: the importance of a coordinated partnership

Given the existing and upcoming challenges, the decades to come will require both institutions and stakeholders to amplify their endeavours to ensure the pace of innovation does not slow down or lose its focus.

It is essential to implement SESAR solutions more quickly and effectively to provide the enhancements that ATM stakeholders and EU citizens expect from the aviation industry. This will require adjustments to the existing ATM innovation cycle so that SESAR can continue to pursue its overarching objectives while also preserving Europe's industrial competitiveness in the global market.

To this end, the industry and EU institutions have started a comprehensive discussion on how to adjust the functioning of SESAR, also in the light of the recent adoption of the Single European Sky 2+ package. Different options are being evaluated, and careful analysis and implementation of them would mark a decisive moment for the industry and Europe. Regardless of the specifics of the future setup, it is essential for the scenario to build on the experience gained in recent decades, both preserving elements which are deemed essential for future success and tweaking its functioning to address generally acknowledged shortcomings.

This would require collective decisions and actions based on a set of critical pillars and lessons learnt:

Coordinated deployment: the first and most evident lesson is that the technological availability of new solutions is not – in itself – self-sufficient in driving effective ATM modernisation. Investments should be organised, stand-

⁷ European ATM Master Plan 2025, as published by the SESAR 3 Joint Undertaking and available at www.sesarju.com

ardised and deployed in a coordinated manner across the network to secure operational results and address the intrinsic interdependences of the European ATM system. Large-scale investments – when duly coordinated beyond national borders or among different stakeholders – regularly outperform individual and locally oriented initiatives, and no acceleration would be feasible without such coordination in the future;

Collaborative governance: it would be particularly important to preserve the *co-creation* model, which has proved its critical added value in the SESAR Deployment Manager setup. The success of industry-wide deployment heavily relies on industry-wide engagement and influence in the decision-making and consultation processes, and also at the management and working levels. It was only by bringing together the major sector players/investors (airlines, ANSPs, airports, EUROCONTROL) in a single coordination vehicle that Europe was collectively able to prioritise investments and synchronise deployment plans for common projects. This model – in which decisions are drawn up and prepared by teams encompassing all views and perspectives arising in the industry – should be reinforced and expanded in scope, even beyond the coordination of common projects;

Investment leverage: the availability of EU co-funding under the Connecting Europe Facility has been widely acknowledged as instrumental in supporting and de-risking large-scale projects. The existing funding incentives – in particular for first and early implementers – should continue and be expanded also in the future setup. This is particularly relevant for technologies the benefits of which are poised to spread across the European network rather than only affect the local dimension.

Performance alignment: at the same time, other incentives should be evaluated and – when possible – applied. The existing performance scheme includes targets and incentive mechanisms yet they are mostly focused on cost-effectiveness objectives. Therefore, they sometimes can hinder the propensity of stakeholders to invest in technological upgrades that have a longer-term return. Such provisions in the scheme and its functioning could therefore be adapted to avoid counterproductive effects on ATM modernisation.

The future organisation of the ATM innovation cycle should take into due consideration such elements and build on their specificities. This should remain the preferential path to help maintain and secure the competi-

tiveness of the European aviation industry on the global stage, and contribute to the different EU policy priorities in which the air transport sector plays a critical role.

Modernising Europe's Air Traffic Management System: The Future of Innovation and the Role of EUROCONTROL

Tânia Cardoso Simões, Aviation Transformation Director at EUROCONTROL

Europe's air traffic management (ATM) system is entering a decade of structural transformation driven by sustained traffic growth, geopolitical uncertainty, climate imperatives, new airspace users and accelerating digitalisation. EUROCONTROL's unique combination of operational responsibility, a pan-European mandate and technical expertise positions the agency as a cornerstone of this transformation – linking research and innovation to deployment and day-to-day operations, and translating policy ambition into measurable performance outcomes. This article presents how the agency, in cooperation with member states and stakeholders, is enabling a more resilient, efficient and sustainable European ATM network. It highlights persistent gaps between innovation and operational impacts and concludes by emphasising the needs to reinforce innovation, align governance and incentives, and integrate data, infrastructure and the human dimension in support of the Digital European Sky vision.

The Case for Accelerating European ATM Modernisation

The current aviation context is shaped by geopolitical instability, modest economic growth and evolving social dynamics. Conflicts such as the war in Ukraine and tensions in the Middle East are disrupting Europe's airspace and increasing military use and operational risks. At the same time, economic pressures like inflation, high interest rates, and constrained public budgets may dampen demand for short-term air travel, although long-term growth remains expected. Socially, demographic changes and younger people are driving demand while also transforming the aviation workforce, creating both opportunities and challenges in terms of skills and talent retention.

Technological and environmental factors are also playing a major role in reshaping the sector. Digitalisation and artificial intelligence are improving efficiency and data use but are also introducing new cybersecurity risks. Advances in aircraft technology and integration of drones and new aerial vehicles require closer civil-military coordination and updated systems. Meanwhile, sustainability remains a central priority with policies promoting greener flight paths and reduced environmental impacts, even as competing priorities like defence spending emerge. Climate change is also increasing operational disruptions, with extreme weather becoming a significant cause of delays.

Legally and operationally, new frameworks such as the SES2+ Regulation aim to modernise Europe's aviation system while balancing growth, efficiency and sustainability and ensuring the competitiveness of Europe's ATM industry.

Air traffic is already surpassing pre-pandemic levels and is expected to continue to steadily rise. On an average annual basis, a EUROCONTROL forecast indicates projected traf-

fic growth between 2025 and 2031 of approximately +2.2% per year, potentially reaching up to 50,000 daily flights by 2030. By 2031 more than 12.4 million flights are expected in the European ECAC area.^{1 2}

This growth will increase system complexity and volatility. As a result, the sector must invest in infrastructure, strengthen international partnerships and enhance air traffic management capabilities to handle greater demand and emerging challenges.

The strategic response to this challenge has been codified in Trajectory 2030,³ which considers the proactive role of the NM – matching capacity and demand, optimising cross-border operations and assessing the cumulative network effects of individual operational choices. The strategy also recognises European research and innovation beyond 2030 in line with SES2+⁴ and the European ATM Master Plan (EATMP)⁵ and creates a window to reinforce the role of EUROCONTROL in innovation, deployment and stakeholder cooperation, also taking into account its civil-military nature

SES, SES2+ and the Master Plan: The Policy and Planning Backbone

Innovation has become a critical enabler of the performance, resilience and sustainability of the European ATM

1 EUROCONTROL 7-year forecast (updated in October 2025), base scenario.

2 The aviation long-term outlook 2024–2050 forecasts around 16 million flights per year by 2050, representing an increase of approximately 44% compared to 2019 in the base scenario.

3 [Trajectory-2030-Strategy-Full](#).

4 Regulation (EU) 2024/2803 of the European Parliament and of the Council of 23 October 2024 on the implementation of the Single European Sky (*OJ L*, 2024/2803, 11.11.2024).

5 [SESAR Joint Undertaking | European ATM Master Plan](#).

system, as is clearly evidenced by the outcomes delivered by SESAR and the strategic orientation set by the ATM research and innovation strategy (ARIS).⁶ SESAR has demonstrated that coordinated pan-European innovation can translate complex operational challenges into deployable solutions and delivering tangible results in areas such as trajectory-based operations, network management, automation support, environmental performance and integration of new airspace users. With structured research, industrial validation and early deployment, innovation has contributed to measurable improvements in predictability, capacity utilisation, flight efficiency and operational resilience, while also reducing the gap between research and real-world operations. These results confirm that innovation is no longer a peripheral activity but a core mechanism to maintain system performance with growing traffic, climate constraints and operational complexity.

The European ATM Master Plan (2025 edition) – endorsed on 12 December 2024 – sets the Digital European Sky roadmap and remains the common reference for modernisation priorities among stakeholders. The SES2+ Regulation, in force since 1 December 2024, strengthens the centrality of the Master Plan and updates the functions of the NM, including coordination, monitoring and support for ATM infrastructure deployment in partnership with operational stakeholders.

To translate planning into execution, the NM contributes to synchronising operational and technological evolutions impacting the network. This builds on the deployment manager (SDM), which partners, supports and accelerates execution of SESAR deployment.

At the same time, studies emphasise persistent system-level gaps – phase-to-phase integration, industrialisation and incentive mechanisms – which require more coherent governance and stronger operational anchoring.

The Roles of EUROCONTROL in Practice: From Daily Operations to System Change

The NM focuses on air traffic flow and capacity management (ATFCM), dynamic operation planning, airport-network integration, airspace design and utilisation, civil-military cooperation, CNS monitoring and evolution (with the CNS programme manager), information security, crisis management, forecasting, training and network performance – connecting operational dots that no single actor can connect alone. This mission is reinforced in the Agency

Business Plan and Trajectory 2030 as the lever to accelerate sector capacity and modernise the NM system.

In 2025, the NM advanced the CNS Evolution Plan 2026 and emphasised CNS resilience to rising global navigation satellite system (GNSS) interference, thus contributing to the resilient operational network (RON) concept – an evolution of the former minimal operational network. The NM also strengthened monitoring (datalinks, GNSS, surveillance, altimetry) to detect anomalies and coordinate mitigations. The draft European ATM Network Infrastructure Monitoring function defines the scope of pan-European monitoring of the functioning, performance and capacity of the network, with real-time mechanisms and reporting to governance bodies and states.

GNSS radio-frequency interference (including spoofing) has escalated in Europe and is flagged as a top short-term challenge. EUROCONTROL and partners coordinate mitigation with a joint action plan with EASA, combining operational monitoring and long-term navigation upgrades. The CNS programme manager – working with states and stakeholders – translates this into a coherent CNS evolution trajectory, while the proposed European ATM infrastructure monitoring function institutionalises pan-European performance oversight, early warning and follow-up.

EUROCONTROL is also mandated by SES2+ to help coordinate ATM infrastructure implementation in partnership with operational stakeholders, by aligning regulatory, operational and investment timelines.

With its engagement in SESAR and the European ATM Master Plan, EUROCONTROL connects research priorities with deployment pathways and SES performance objectives, supported by performance assessments, simulations and cost-benefit analyses, thus helping to ensure a coherent single ATM value chain from R&D to operational deployment. This includes close coordination with the network manager, the SESAR deployment manager, EASA and industry partners to accelerate industrialisation of solutions, support decision-making and align innovation with operational and regulatory needs.

In parallel, EUROCONTROL provides extensive stakeholder, state and international support, which underpins ATM modernisation and interoperability across Europe and beyond, including tailored technical support for states on priority topics such as cybersecurity, sustainability, drones and ATM security.

⁶ Aviation Research and Innovation Strategy.

EUROCONTROL makes a tangible contribution to the European ATM community by providing trusted data, forecasts and performance analysis that directly support operational planning, policy decisions and regulatory processes. With activities such as European traffic forecasts, network and airport performance monitoring and analysis of delays and capacity constraints, EUROCONTROL enables ANSPs, airspace users, airports, member states and the network manager to anticipate demand, identify bottlenecks and assess the impact of operational and policy choices. Concrete examples include use of traffic and delay analysis to support seasonal and strategic capacity planning, cost-benefit analyses underpinning SESAR and network manager initiatives, and independent performance assessments that inform discussions on ATM efficiency, capacity, cost and environmental performance.

In addition, EUROCONTROL strengthens the ATM community by improving transparency, comparability and access to ATM data across Europe. Regular performance and benchmarking reports, operational dashboards, data snapshots and forecasting updates provide a common evidence base for stakeholders and support informed dialogue between regulators, service providers and users. With its analytical work, EUROCONTROL supports both the Performance Review Commission (PRC) under the EUROCONTROL Convention and the Performance Review Board (PRB) of the Single European Sky in a complementary manner and ensures coherence between the two frameworks. By providing a consistent transparent evidence base on ATM performance, EUROCONTROL enables effective performance oversight for its member states while supporting the European Commission's regulatory role. With these concrete contributions, EUROCONTROL acts as a neutral reference point for ATM performance and trends, thus helping the community move towards more data-driven, coordinated and sustainable decision-making.

EUROCONTROL plays a central role in supporting European and global aviation sustainability by providing concrete technical data and modelling capabilities that underpin environmental policy design, regulatory implementation and international coordination. With sustained support for member states, the European Commission, EASA, ECAC and ICAO, EUROCONTROL delivers essential services such as emission monitoring and reporting for EU ETS and CORSIA, fuel and emission inventories, and independent environmental assessments. Its advanced modelling tools for CO₂ and non-CO₂ emissions, noise and air quality are widely used in regulatory contexts, research and innovation programmes (including SESAR and Horizon Europe), and

by states and international bodies to meet environmental obligations and reporting requirements.

In parallel, EUROCONTROL supports the transition of the aviation and ATM community towards net zero and greater climate resilience with forward-looking operationally grounded initiatives. The FlyingGreen platform provides a one-stop practical decision-support environment for stakeholders covering emission pathways, sustainable aviation fuels, climate adaptation and access to sustainable finance. EUROCONTROL also applies its environmental data and expertise to operational decarbonisation, working with the network manager, SESAR partners and military stakeholders to improve flight efficiency and network performance. Its work on non-CO₂ impacts (including contrails), climate change adaptation and integration of new aircraft technologies further strengthens the sustainability and resilience of the European ATM system, translating strategic climate objectives into concrete actionable support for the aviation community.

Last but not least, EUROCONTROL plays a central role in driving innovation across the European ATM system by acting as a bridge between research, operations and deployment. With its Innovation Hub and structured engagement in the SESAR programme, EUROCONTROL delivers innovation as a service and simulation as a service, ensuring that emerging technologies and new operational concepts are matured, validated and made deployable for the benefit of the network, ANSPs, airports, airspace users and member states. Innovation activities are explicitly aligned with the European ATM Master Plan and focus on addressing key system challenges, including capacity growth, resilience to weather and disruptions, environmental performance, digital transformation and safe integration of new airspace users.

A core pillar of this approach is the EUROCONTROL Air Transport Innovation Network (EATIN), which acts as an idea incubator for emerging technologies, in which operational stakeholders identify real problems and rapidly prototype solutions for live or simulated use, and later scale them up across the network. It has produced tools such as AI-enabled early diversion prediction, large-scale diversion management, real-time delay sharing and airport weather impact assessment, many of which are already operational or ready to deploy.

Innovation is also embedded in operations with data-driven tools like iFlow and CROSSMET, which improve flow optimisation and weather awareness. These enable more responsive planning and dynamic rerouting around con-

straints, thus enhancing resilience, efficiency and performance.

In parallel, EUROCONTROL actively supports the integration of new airspace users and operating concepts, notably with its work on U-space and higher altitude operations (HAO). This includes bridging research and innovation with states' regulatory and operational needs by providing concrete implementation support, guidance, simulations and technical tools. EUROCONTROL has supported U-space implementation with workshops, airspace risk assessment methodologies, simulation activities and deployment of operational tools in multiple member states, while also contributing to the validation of concepts for higher altitude operations such as high-altitude platforms and new long-endurance vehicles. These activities ensure that innovation is translated into practical, safe and interoperable solutions that can be adopted consistently across the European ATM system.

Together, these innovation activities demonstrate EUROCONTROL's role as a neutral enabler of ATM innovation delivering measurable operational value, accelerating time-to-market for new solutions and ensuring that innovation efforts are closely connected to deployment and network performance objectives rather than remaining confined to research alone.

What 'Good' Looks Like by 2030: A Target End-State

EUROCONTROL's internal analyses and external studies converge on the need to close the gaps from innovation to deployment, strengthen industrialisation pathways and align incentives with operational outcomes, particularly in the context of the next Multiannual Financial Framework (2028–2034). Tools such as the ATM Transformation Portal directly address these challenges by improving transparency on solution maturity, deployment progress, performance impacts and investment needs, thus reducing complexity for decision-makers. Adequate governance and funding are key.

Realising this vision also requires human-system integration: upskilling engineers and operators for AI-enabled software-defined environments and bringing staff associations and professional communities fully into transformation dialogues.

Actions are needed across the entire ATM value chain – from early research to operational execution – and at the political level to ensure effective modernisation. This includes providing strong strategic steering of the ATM Master Plan

2025 to align policy and deployment priorities, focusing development on high-impact operational and technical solutions, and accelerating research, innovation, regulation and standardisation to avoid deployment bottlenecks. It also requires simplifying or better supporting certification processes to prevent capacity constraints, thus ensuring co-ordinated and synchronised deployment of key ATM solutions and addressing broader political and structural barriers that limit ATM optimisation, such as fragmented charging schemes, cross-border service provision, certification and licensing constraints, the number of ATS units and airspace design still driven by national borders rather than operational needs.

So, if we want to turn momentum into measurable outcomes, we need to:

- stabilise governance of the innovation-to-deployment chain, thus ensuring continuity across phases and linking to the final outcome: operational innovation.
- select a model that maximises operational anchoring and stakeholder trust aligned with incentives and performance schemes, ensuring oversight of industrialisation, deployment and funding cycles.
- implement the European ATM infrastructure monitoring function with real-time alerts and governance reporting, linking findings to CNS evolution and RON mitigations.
- harden CNS against GNSS RFI and accelerate surveillance and communication upgrades by scaling monitoring, adopting multilink solutions and embedding resilience criteria.
- embed environmental aims in operational planning and performance schemes for climate-optimised trajectories.

Europe's ATM transformation is no longer about isolated pilots or single-technology upgrades; it is a system change and this change needs to be managed with the contribution of all the stakeholders involved, so Europe can deliver a modern, resilient and sustainable ATM system by 2030 and beyond.

A mindset dedicated to the evolving aviation imperative to harness SES 2+

Achim Baumann, Policy Director at Airlines for Europe (A4E)

Setting the scene

Aviation in Europe is at a critical turning point. If we want aviation to continue to grow, Europe's leaders must choose a path towards increasing connectivity and ensuring the competitiveness of Europe and of European airlines. People want and need to fly, with demand expected to increase by 3% in 2026 (Eurocontrol Jan 2026) and load factors averaging 88% in 2025, and for some A4E member airline groups up to 94%. In 2025 A4E members flew almost 800 million passengers and together offered over 2,700 destinations. More routes and better connectivity are propelling economic growth.

We cannot continue to take these levels of accessibility of air travel and connectivity for granted. European airlines and passengers face increasing regulatory costs, which just for A4E airlines have tripled since 2014 to €15.5 billion annually and are set to rise to €27.6 billion per year in 2030.

Fragmented European airspace, insufficient capacity and slow implementation of new technologies create inefficiencies that cost A4E member airlines €4.7 billion in 2024. The Single European Sky and the framework regulations SES I and now SES 2+ were designed to fix this situation and create a growth path for aviation.

This article outlines some priorities and principles from an airline perspective on how to use the possibilities that the adoption of SES 2+ brought about and gives ideas on what a more cooperative and efficient future needs.

We have the chance to re-shape the aviation landscape with new a regulatory environment that supports efficient use of technology, more cooperation and harmonisation by focusing on achieving common aims in the aviation industry: keep aviation growing, get passengers to their destinations on time and keep Europe connected.

How it all started

Already at the end of the last millennium the aviation community realised that growing air travel demand and the subsequent increase in flights would stretch the exist-

ing airspace capacity. That was the time when I entered the civil aviation world.

- 1999-2004: Launch of initiatives to reform air traffic management by the European Commission.
- 2004 (SES-I): Regulation (EC) 549-552/2004, focusing on breaking up national monopolies and establishing National Supervisory Authorities (NSAs).
- 2009 (SES-II): Regulation (EC) No 1070/2009, shifting the focus to performance, environmental challenges and the SESAR technology programme.
- 2013 (SES 2+ Proposal): The Commission proposed a 'Plan B' to speed up implementation, but negotiations stalled in 2015.
- 2020 (the SES 2+ Proposal amended): EC) 2024/2803, to improve resilience and align with the European Green Deal.

I have been around all this time, and I have seen numerous initiatives, regulatory ones like SES or technical like the SESAR JU,¹ trying to ensure that technology and operations are able to provide the capacity needed for this growth while improving safety levels. According to various sources air traffic in Europe and globally has more than doubled and passenger numbers have increased about 10-fold since the 1980s/90s.

Until today we have mainly been patching things up and keeping the aviation system working. Overall, this has worked but it clearly came to its limits in 2018/19 and again in 2024/25 when ATFM delays skyrocketed to over 30 million minutes. This made 2024 the worst year of this millennium.

I fondly remember the ATM 2000+ strategy before SESAR came alive. Looking at what this strategy outlined and comparing it to what we are discussing today, the ATM Master Plan, there is a significant overlap between the two. Some of the ideas sounded like science fiction in the late 1990s; others lacked computing power in the early 2000s to make them feasible. Now that we have advanced in gen-

¹ Single European Sky ATM Research Joint Undertaking

eral computer technology and had at least two more decades for research, what is the excuse today for not implementing what we thought should have been done 10 years ago? Why do some things still sound like science fiction although artificial intelligence is around the corner and computing power should not be an issue anymore?

However, I think today it is more important to identify how to move forward swiftly and implement what we have. I do not want to ask the same questions when I retire.

How do we get it right?

With SES 2+ adopted – and disregarding its many shortcomings – it had a significant impact on all the parties involved. All of us exchanged and discussed our views during the drafting and consultation process. These discussions improved understanding between the different stakeholder groups like airlines, airports and air navigation service providers (ANSPs). Exchanges did not always lead to common agreement but at least we could agree to disagree.

With this understanding established and a new regulation in place, all the parties involved are reviewing their stance and have become more open minded. The last Florence Air Forum in October 2025 served as living proof of this change in interaction.

Governance, decision-making and consultation

Cooperative decision-making (CDM) in the context of the Single European Sky (SES) 2+ is defined in Article (2) (29). ‘Cooperative decision-making’ means a process in which decisions are made based on interaction and consultation with the relevant member state authorities, operational stakeholders and other actors as appropriate, and aiming to achieve consensus. CDM is a critical mandated process to foster cooperation between stakeholders such as airlines, ANSPs, airports and also states and other parties.

SES 2+ aims to reduce fragmentation in European airspace and accelerate the implementation of performance-based cost-effective air traffic management. The role of all stakeholders in this endeavour is to cooperate and provide input on service provision, safety and technological improvements – and to implement agreed measures.

Key aspects of consultation in the SES 2+ framework include:

- Performance plan development;

- Economic and operational consultation;
- Addressing fragmented airspace.

In fact, the word ‘consultation’ shows up 17 times in the SES 2+ text and several articles, namely Articles 40 and 49, explicitly address consultation.

Governance, decision-making and consultation are crucial elements in a multi-stakeholder environment such as aviation. Only when those who pay – the airspace users – and those who deliver the services, such as airports and ANSPs, commonly participate in decision-making, will outcomes be accepted and will implementation be supported. In this context, an independent and overarching perspective is necessary to minimise fragmentation.

All the regulations in the SES framework address governance, decision-making and consultation in one way or another. They define processes to involve stakeholders in decision-making or establish bodies that support European organisations in their decision-making. With SES 2+ and the evolution of technologies, a new challenge has emerged: how to enable a shift toward more strategic planning. As a result, a more holistic system is required – one that aligns the pathway from strategic to operational decisions and from research to deployment.

Article 49 describes stakeholder consultation in more detail and links it to additional implementing regulations. Today, two such regulations are the Network Function Implementing Rule (NFIR) and the Performance and Charging Scheme. Both regulations will need to be updated to reflect the changes in SES 2+ (e.g. new network functions) or address known shortcomings (e.g. outdated key performance indicators). Amending these regulations should be forward looking and should ensure effective use of technological improvements. The amendments should not focus on patching past mistakes but rather on creating a less challenged aviation environment.

Having said this, CDM should never become a mere ‘tick-box exercise.’ It must always be constructive and transparent, and lead to solutions that are jointly accepted and supported.

Network functions

According to SES 2+ these network functions must ensure efficient and sustainable use of airspace and scarce resources. From an airline perspective we would expect the

functions to result in an efficient airspace and sufficient capacity to allow airlines to fly efficient trajectories – taking passengers and cargo to their destinations without delay. As such, the network functions are in a good place to use a constructive ‘after SES 2+ adoption’ mindset to implement forward-looking changes and help aviation evolve.

With the nine functions defined in SES 2+, we have a more granular system better suited to organising and running network services more efficiently. For airlines some of these functions are of specific interest as they have a direct impact on flight performance and delays:

- Air Traffic Flow Management (ATFM) – an existing function;
- Facilitation of delegation of air traffic service provision – a new function with new tasks;
- Delivery of air traffic control capacity in the network – a new function with new tasks.

For the ATFM function, airlines would expect to see a forward-looking planning process with a focus on capacity-building and capacity-steering even across borders to ensure that capacity matches demand. The current way of matching demand with capacity should only be used in cases in which adapting capacity is no longer possible – e.g. due to changing weather conditions or ad-hoc capacity constraints.

For the two new functions airlines would like to see a flexible and demand-based provision of capacity. This includes efficient demand-based capacity planning processes and a continual improvement process for ANSPs and the network manager supported by the Performance and Charging Regulation. In addition, delegation of ATS Provision in a given airspace structure and across national borders should be easy to allow best use of currently available air traffic controller resources and capabilities. This links directly to airspace efficiency and the subsequent benefits of efficient trajectories.

I do not aim to analyse each of the functions but there are a set of points all functions and related tasks that those carrying them out should implement:

- A paradigm shift to ‘capacity follows demand,’ more strategic capacity-planning focusing on capacity-building and capacity-steering even across borders;

- Accommodate new entrants without impacting existing civil operations;
- Balance civil and military requirements in a mutually beneficial way;
- Deploy technology as agreed;
- Use efficient and inclusive CDM processes.

ATM funding, performance and charging

The performance and charging scheme established in the SES 2+ framework is designed to mitigate the monopolistic ANSP environment and create a competitive market. This should ensure that air navigation services are delivered in a cost-efficient, transparent and performance-driven manner while maintaining the highest levels of safety and capacity.

COVID-19 showed that neither the current system of ATM funding nor the performance and charging scheme are resilient in such a crisis. During COVID citizens were not able to travel and airlines were not able to fly. Nevertheless, air navigation services were offered almost as usual. The patches applied to the system during COVID shifted payments for these unusable air navigation services right into the recovery period of the airline business, thus increasing ATC charges and creating an additional financial burden.

It is a fact that aviation is an outlier when it comes to funding its systems and infrastructure. A study by A4E shows that there are funding methods in other industries, even in transport, which apply different concepts that are more resilient and fairer in their cost distribution. Aviation is the only mode of transport fully financed by users, even those parts which can be considered critical services of general interest to EU citizens.

The future of ATM funding needs to address the different positions of states, airlines, airports and ANSPs, accept business cases of different entities and define financing streams to ensure efficient deployment of technology.

Another upcoming challenge will be to integrate autonomous systems seamlessly in the existing aviation system. The main issue will be exclusive demands for airspace, e.g. for space launches which go beyond air navigation services. The user pays principle as it is currently implemented by the ATM funding principles and the existing charging systems focus on the use of services not the use of airspace.

A future update to the charging regulation will have to include a compensation mechanism for new entrants to offset the cost impact (fuel usage, time, etc.) on other air-space users.

For all the issues mentioned above, the performance and charging scheme plays a key role in supporting change, efficiency and continual improvement. To do all this the indicators used to measure performance in the scheme need to be sensitive and allow analysis to identify improvements. Furthermore, the indicators need to be linked with an incentive scheme that targets the stakeholders responsible i.e. ANSPs and the NM. Incentives connected to the performance indicators need to have the power to sway behaviour in the intended direction and keep it there.^z

Conclusion

With the adoption of SES 2+, the aviation system can perform the switch from patching things to fixing things. We can only achieve this if we continue to spread a mindset of using SES 2+ more creatively. Although creativity is a good thing – especially if its aim is to evolve the aviation industry – it needs to be channelled in one common direction and aim at one common target: keeping Europeans and their businesses connected and airlines thriving – maintaining accessibility to flying for people as a fundamental and integral part of the EU transport infrastructure.

Network governance and the law: How to govern the execution of network functions?

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The air traffic management (ATM) system in Europe is undergoing a fundamental change. The traditional patchwork of relatively isolated national airspace volumes and vertically integrated national infrastructure blocks with limited interoperability are gradually being replaced by an EU-wide ATM network. Airspace structures are expected to be established with less regard to national borders in the framework of a gradually more integrated EU airspace and national in-house pieces of infrastructure are expected to be progressively replaced with network capabilities and market-based services. To make this happen, the SES 2+ Regulation has strengthened and extended the central EU functions of the Single European Sky, the network functions. The SES 2+ Regulation requires the member states and the operational stakeholders to execute these functions. At the same time, there are considerable uncertainties surrounding the governance and decision-making procedures related to the execution of the network functions. These include the actual scope of the network functions, a choice between light and strict governance, the roles and responsibilities of the stakeholders involved and the potential legal consequences of their actions. This article argues that such uncertainties lead to inefficiencies. Therefore, they must be addressed and there is a need for clear governance arrangements and a legal environment which ensures efficient execution of the network functions.

Introduction: The Network Functions of the Single European Sky

The Single European Sky (SES) is an ambitious policy initiative of the European Union (EU) the aim of which is to make the European air traffic management (ATM) system more efficient. Its objectives include reducing flight delays, increasing safety, sustainability, cost efficiency and creating a seamless European aviation system which is not hindered by non-compatible technologies and inefficient airspace structures designed within the constraints posed by national borders. Since the inception of the Single European Sky (SES) in 2004, a significant legal and institutional framework has been developed. This is complemented by a research and development programme supported by generous EU grants. The most recent overhaul of the SES framework was the adoption of the so-called Single European Sky 2+ (SES 2+) Regulation in 2025. The Single European Sky is increasingly focusing on integration of the airspace over the territory of the EU, the technological and infrastructure systems underlying air traffic management and establishing centralised functions at the EU level.

Building on a few existing centralised functions, the SES 2+ Regulation extends their scope and adds new functions to the existing ones, establishing them as the network functions of the Single European Sky. The objective of these centralised EU functions is to ensure smooth operation and development of the entire system. Network functions include the design and utilisation of airspace structures, delivery of air traffic control capacity and planning, monitoring and deployment of infrastructure in the EU ATM network. According to the SES 2+ Regulation, these functions shall lead to sustainable and efficient use of

airspace and scarce resources, shall support seamless access to air navigation services by airspace users, shall achieve Union-wide performance targets, shall ensure that airspace users can operate environmentally- and climate-optimised flight trajectories and profiles, and shall allow fair and reasonable access to airspace and air navigation services while minimising congestion.

The entities obliged to execute the network functions are the EU member states and the operational stakeholders (civil and military airspace users, civil and military air navigation service providers and airport operators). A Union institution, the network manager (NM) is required to contribute to the execution of the functions. The network manager is appointed by the European Commission. Today, EUROCONTROL, a classic international organisation predating the SES initiative and with a broader membership than the EU, holds the title. In execution of the NM role, it is under an obligation to observe the rules of Union law.

Currently, the legislative process to amend the network functions implementing regulation is in progress. This implementing regulation is expected to determine the final shape of the governance of the execution of the network functions within the limits specified by the SES 2+ Regulation.

Establishing an efficient governance arrangement for the network functions as part of the SES institutional framework

In the context of the Single European Sky policy initiative, European air traffic management is perceived as an

EU function and a common task rather than a function carried out by each member state on its own. Relatively isolated national airspace volumes and vertically integrated infrastructure blocks are gradually being replaced by an EU airspace and an interoperable network infrastructure – both organised, managed and developed with decreasing regard to national borders. The main purpose of the network functions is to make the EU system work. This obviously involves establishing centralised functions, monitoring the EU system as a whole, coordination, collaboration and joint decision-making. According to some interpretations of the legal framework, it even involves exercise of public authority at the EU level and adoption of decisions binding the member states and operational stakeholders.

Arguably, governance of the network functions and relevant decision-making processes form an integral part of the institutional framework of the Single European Sky. They have a bearing on how authority is distributed (between the EU, the member states and operational stakeholders), what coordination mechanisms are operated, how airspace structures are designed, how the European ATM network and its infrastructure are developed, how traffic flows are arranged, etc. Governance and decision-making structures are an important part of an institutional framework. Uncertainties, inconsistencies and anomalies therefore weaken not only the effective execution of the network functions, but the entire institutional framework of the Single European Sky.

Therefore, the question arises of what the most important aspects of an effective system of governance are. Effective governance arrangements usually incorporate mechanisms that ensure leadership, a clear distribution of roles and responsibilities, appropriate decision-making processes, coordination and implementation mechanisms, and accountability of the entities involved in governance and execution. Further aspects of effective governance are enforceability, sanctions and legal remedies. Needless to say, in an effective system of governance it is also clear what needs to be governed, and the arrangement is characterised by legal certainty.

In the view of the authors, execution of the network functions does not currently have an appropriate governance framework. The main problem is the legal uncertainty characterising both the actual scope and governance of the network functions. It is not entirely clear what the scope of some of the network functions is and it is not entirely clear whether governance of the network functions involves adopting legally binding decisions. In the case that adop-

tion of legally binding decisions is a possibility, it is not clear what the scope of these decisions may be, how they may be adopted and who they could bind. Furthermore, it is not clear what the source of the binding force may be: an act of a public authority exercising public powers or voluntary acceptance of certain obligations by the stakeholders involved in the coordination processes. There is an obvious need to clarify these issues.

Having said that, establishing an appropriate governance structure for execution of the network functions is a difficult task. There are a broad range of relevant stakeholders including states, intergovernmental organisations, airlines, airports and air navigation service providers. While these actors may have different, sometimes competing, interests, they are in an interdependent relationship and they need to collaborate closely with each other to ensure the smooth operation of the network, the entire European ATM system.

In a decentralised system, network governance is usually a way of managing and coordinating activities in which multiple independent actors with a high degree of interdependence (governments, intergovernmental organisations and private entities) work together in collaborative processes rather than with a strict hierarchy or pure market competition. Instead of a single central authority, governance and decision-making is carried out through a network of participants who wish to achieve common policy objectives. This also means that no single actor has full control and decisions are made through discussion, trust and mutual adjustment.

However, the Single European Sky framework including the network functions is set up in a traditional hierarchical legal environment in which public authority and obligations under international public law play a central role. Before the EU Single European Sky initiative and legislative package, states were obliged under the Chicago Convention to ensure provision of air navigation services in their airspaces together with operation of the necessary infrastructure. In fact, the member states still have this obligation under the Chicago Convention, to which the EU is not a party. The move towards a decentralised system may be perceived as a legal paradigm shift.

Even the original concept of the SES 2+ Regulation entertained the idea that some form of public authority would be exercised in the context of the execution of the network functions. As a remnant of that approach, the text of the regulation includes a provision according to which

the network functions shall not involve the adoption of binding measures of a general scope. This may be interpreted as meaning that binding measures that are not of a general scope (i.e. binding individual entities) may indeed be adopted. Another example is a provision requiring the consent of the member states when CDM decisions would concern their sovereignty over their airspace.

It may also be argued that while the system is becoming decentralised there is a parallel tendency of centralisation in the context of the Single European Sky. This involves establishing new EU level functions and the elements of the European ATM infrastructure that are responsible for providing the foundational functions for the entire network.

In these circumstances, designing a robust system of governance for the network functions is indeed a formidable task. Perhaps the fundamental question is that of how the network functions are to be best incorporated in the SES framework. Are they to be perceived as purely coordinative functions leading to informal agreements without legal effects or do they involve 'hard' decision-making with legal consequences and legally enforceable agreements? These two approaches necessitate entirely different arrangements.

In the case that the network functions are perceived as purely coordinative functions, the system of governance should follow this approach (light or flexible governance). There is no space for legally binding decision-making, and even strategic decisions involving the member states are only there to provide guidance and recommendations. Voluntary engagement and use of peer pressure to facilitate compliance are characteristics of this system. It is sufficient to establish appropriate and simple coordination procedures. On the other hand, in the case that the network functions are perceived as functions capable of creating legal effects and enforceable obligations, the governance arrangements need to be more elaborate (hard or strict governance). They should take into consideration the division of competences between the EU and the member states, respect the principles of legal certainty and proportionality, and provide possibilities for legal remedies, enforcement procedures, et cetera. The scope of the network functions must be defined rigorously as must the decision-making powers involved. Decision-making processes must be precisely defined and there is space for strict enforcement mechanisms. Non-compliance may be followed by legal sanctions.

The choice between light governance and hard governance will therefore determine the legal framework. And if it is well-designed, the legal framework will be capable of bringing clarity and certainty to the institutional framework and the governance and the decision-making processes.

A brief assessment of a few legal aspects of the execution of the network functions

First, there is a need to briefly touch on what one may learn about the governance of the execution of the network functions from the SES 2+ Regulation, the legal instrument that establishes the system. The SES 2+ provides an exhaustive list of the nine network functions, but it does not define their scope. While a network management board is established "with a view to ensuring appropriate governance over the execution of the network functions," it is unclear what the legal consequences of the actions and decisions of the board may be. The exact role of the member states in the governance and decision-making processes is also an open question. The nature of the accountability of the entities involved in the execution of the network functions is not defined either. At present it is not entirely clear whether network governance (CDM) is a purely coordinating process or may involve the establishment of legal obligations for the entities involved in one way or another. A decision-making process leading to adoption of recommendations or declarations of intent without binding legal force needs entirely different structures to a decision-making process leading to legal obligations.

Even though the regulation is silent on legal effects, legal remedies and a potential exercise of public powers through the governance processes in question, certain provisions may be interpreted as having the potential to create legal effects (e.g. the need for member state consent when sovereignty over the airspace is involved and the explicit prohibition of adopting binding measures with a general scope). Despite the uncertainties and inconsistencies involved, the legal framework for the governance of the execution of the network functions is established by the SES 2+ Regulation. This situation creates considerable legal uncertainty.

In these circumstances, it is safe to argue that the SES 2+ Regulation leaves abundant space for interpretation. And the existing gaps should indeed be filled by interpretation. While it is the Court of Justice of the European Union (CJEU) that holds the exclusive power to provide authoritative final interpretation of EU law, certain questions must be answered by the legislator before appropriate im-

plementing rules may be drafted. These fundamental questions are the following. Does the SES 2+ Regulation establish a system of light or strict governance? Is there scope for adoption of legally binding decisions in the framework of the execution of the network functions?

The lack of a precise definition of the scope of the network functions and the governance and decision-making procedures involved in their execution, the lack of a definition of decision-making powers and legal remedies, and the lack of a clear definition of the roles and responsibilities of the member states and operational stakeholders in the execution of network functions suggest that the choice of the legislator is the system of light governance. This system does not allow the adoption of legally binding decisions, sanctions and strict enforcement mechanisms. Instead, it is an approach favouring flexibility that puts trust, goodwill and sincere co-operation in focus. This perception of the network functions is entirely within the scope of the SES 2+ Regulation without any doubt.

This legislative choice implies that decision-making in the CDM process is not an exercise of public authority and the decisions adopted do not have legal effect. In other words, the entities involved in executing the network functions (member states and operational stakeholders) cannot be subject to legal obligations with network governance. Of course this does not prevent the entities involved from entering into legal relationships and accepting legal obligations voluntarily. Decisions made in the context of the execution of the network functions are only recommendations or declarations of intent. They cannot be enforced and non-compliance cannot be sanctioned. Governance mechanisms may still include monitoring and follow-up activities, but since the decisions do not carry legal effect and obligations cannot arise from them, accountability for complying with those decisions cannot be established.

The question still arises of whether an indirect legal effect may be established on the basis of CDM decisions. This could be the case when economic regulation (e.g. in the context of the Single European Sky performance and charging scheme) sanctions non-compliance with CDM decisions. For instance, performance plans that are not in compliance with CDM decisions would not be approved and failure to comply with technological development plans would lead to imposition of a financial disincentive. It is the view of the authors that such arrangements would only be possible if CDM decisions were clearly defined by the SES 2+ Regulation as acts of a public authority or in

the case that the entities involved have expressly and voluntarily accepted such legal consequences.

Conclusion: The light governance mindset

As it is clear from the evolution of the network functions that they are gradually becoming the defining centralised EU functions responsible for the operation of the EU ATM network, the inconsistencies and uncertainties identified raise the question of whether the current arrangement is appropriate to ensure the effective execution of the network functions.

Establishing an efficient governance system for the execution of the network functions is a complex task, especially given the broad room the provisions of the SES 2+ Regulation leave for interpretation. Still, the legislator needs to accept the legal uncertainty created by the regulation and establish the best governance system possible for the execution of the network functions within the boundaries provided. In conclusion, the authors will endeavour to make a few proposals to address the problems and move forward.

Once the light governance option is accepted, much of the legal uncertainty falls away. There is no more need for a precise definition of the scope of the network functions, they and the relevant coordination mechanisms can be flexible, taking shape in accordance with the needs of the network. As no obligations arise from decisions, the division of competences becomes a less problematic issue. There is no need for appeal procedures, judicial remedies, enforcement mechanisms or sanctions. When legal obligations are needed to achieve policy objectives, it is necessary to find or establish legal bases for such obligations outside the legal framework of the network functions.

Having said that, it would be beneficial to clarify in the implementing regulation that governance of the network functions involves purely coordinating processes. It should be acknowledged that creating accountability is not possible without obligations. In the context of execution of the network functions only moral obligations may be created, but these are not recognised as obligations by the law. Sanctions, strict enforcement and creation of indirect obligations are not possible, but peer pressure may be applied and positive incentives may be reserved for stakeholders who comply. Voluntary acceptance of obligations and legal consequences may still be a possibility. Coordination procedures may be streamlined and simplified, and canonisation of light governance can help clarify the roles and responsibilities of the stakeholders involved. The light

governance arrangement may be strengthened by robust monitoring and follow-up mechanisms, but these cannot entail imposing sanctions.

Overall, on the basis of the SES 2+ Regulation it is not currently possible to apply a strict governance regime to the execution of the Network Functions. While a purely coordinating system lacks the possibility to impose obligations and enforce them, its advantages are flexibility and the potential to achieve a truly cooperative approach. Appropriate leadership and an ability to forge consensus could be powerful catalysts in this approach. Furthermore, it needs to be borne in mind that the governance of the network functions is only one element of the Single European Sky framework, and it may be complemented with appropriately defined legal obligations where necessary. Only time will tell whether the light approach will be sufficient to achieve the objectives of the network functions.

The New Service Delivery Model in the Single European Sky: a Paradigm-shift in Air Traffic Management?

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Since the 1990s, European air traffic management has been characterised by persistent inefficiencies, delays and structural fragmentation. In response, in the early 2000s the European Union launched the Single European Sky (SES) initiative, aiming to establish a more unified and more efficient airspace management system. Over time, the SES policy framework and its associated legislation have undergone continual development. However, successive reform efforts have fallen short of delivering fundamental changes in several key aspects of the system. Against this background, according to the current SES policy direction, increasing emphasis on technological and infrastructure innovation may offer the most realistic chance of achieving substantive transformation. Such a transformation would constitute a paradigm shift, encompassing not only the technological, infrastructure and operational dimensions, but also the legal and competition aspects of European air traffic management. The new service delivery model provides an analytical lens for the examination of both the nature of this emerging paradigm shift and the challenges associated with its implementation.

Introduction

The Single European Sky (SES) initiative of 2004 established a policy and regulatory framework for transforming the traditional air traffic management (ATM) system in the European Union (EU). The main objectives were to increase the efficiency of the system by reducing delays, to reduce the cost of ATM, to mitigate the environmental impact of aviation and to enhance aviation safety. The SES vision also entailed creating a unified EU airspace and ensuring interoperability of the infrastructure underlying the provision of air navigation services. Both the SES policy and regulatory frameworks have been evolving dynamically ever since the entry into force of the SES regulations in 2004. This evolution has been characterised by a continual transfer of competences from the member states to the EU and a constant evolution of policy objectives. Now, the European ATM sector is increasingly perceived as a network with centralised functions rather than a patchwork of fragmented national airspace volumes, service providers and infrastructure blocks. Establishing the technological and infrastructure foundations of the European ATM network is becoming one of the most significant aspects of this transformation.

The following sections outline the traditional *modus operandi* and situate the new service delivery model within the broader policy vision of the Digital Single European Sky. Then, the extent to which this development may constitute a paradigm shift is examined, with particular attention to its inherent complexities and the challenges associated with its implementation.

How traditional ATM works

Before the EU acquired competence in the field of air traffic management in 2004, the legal basis for the provision

of air navigation services was the Chicago Convention of 1944. This international treaty codified the principle of airspace sovereignty and made it the responsibility of the signatory states to provide aircraft using their national airspace with air navigation services and to ensure the operation and development of the infrastructure necessary to provide these services. This legal arrangement resulted in a fragmented ATM domain. Airspace and infrastructure were (and still are) fragmented by national borders. Furthermore, each state established its own air navigation service provider and developed its entire ATM infrastructure in isolation, which led to technological and infrastructure fragmentation. The sector is still characterised by the existence of vertically integrated national infrastructure blocks. Designated air navigation service providers were established as state owned monopolies. They execute state functions, and their activities are closely connected to the exercise of public powers. In this setting, aircraft using the national airspace are managed by national monopolies making use of national infrastructure. Before crossing the national border in the airspace, aircraft are passed on to the next national monopoly service provider. Each of these national service providers relies on its own in-house infrastructure (radar, ATM system, etc.) and carries out its core functions in a relatively autonomous manner.

The objective of the Single European Sky policy is to substantially reform this traditional system. Over time, the scope of the SES policy has expanded to include strengthening of centralised network-level EU functions, gradual liberalisation of the sector and development of supporting digital infrastructure. At present, there is broad consensus among stakeholders that there is a need to increase capacity in order to accommodate growing and diversifying traffic demand, while also significantly improving the environmental performance of the sector. Many key actors consider that these objectives can only be achieved with a fundamental tech-

nological and infrastructure transformation in the provision of air navigation services. In this context, digitalisation has emerged as a central aspect of the SES initiative.

The Digital European Sky

According to Article 1 (1) of the SES 2+ Regulation, “the Single European Sky shall comprise a coherent pan-European network, a progressively more integrated airspace, network management and air traffic management systems based on safety, efficiency, interoperability and technological modernisation (...)”. The current focus of SES policy is a Digital European Sky. The vision of a Digital European Sky was developed by the SESAR Joint Undertaking from 2017 and explicitly taken on board in a joint declaration by a broad range of industry stakeholders in 2023. The Digital European Sky envisions employing enhanced data sharing, virtualisation and automation to transform Europe’s aviation infrastructure, enabling it to handle the future growth and diversity of air traffic while significantly reducing its environmental impact.

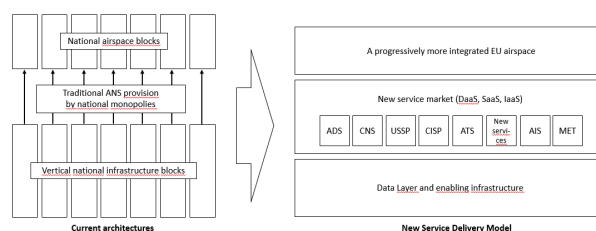
Digitalisation is expected to make Europe’s ATM system more modular and agile, enabling full interoperability, in-depth real-time data analysis and interventions structuring airspace and organising traffic. These capabilities are expected to provide the necessary information and insights to improve aviation safety and environmental performance and to enable flexible capacity allocation within the network. Functions currently executed by national monopolistic service providers making use of in-house infrastructure may be provided by market-based service providers from any point in the network to any other point without geographical or political restraints. Instead of developing their own national infrastructure, air navigation service providers could use the services of market-based digital infrastructure providers.

The new service delivery model (NSDM) has become a key element in this vision. According to the Airspace Architecture Study (2019) it is a new model for ATM data service provision by establishing dedicated (usually profit-oriented) ATM data service providers (ADSPs). ATM data services provide the data and applications required to provide air traffic services (ATS). According to the current version of the ATM Master Plan (2025), the new service delivery model is expected to enhance flexibility, scalability, resilience and innovation with its service-oriented design with open and standardised interfaces based on application programming interface technologies. This architecture is expected to enable faster innovation, a greater degree of automation and seamless integration of new services by facilitating mul-

ti-vendor solutions using open platforms and interfaces and decoupling service and infrastructure layers with cloud computing.

The NSDM concept attains full clarity when situated in the broader context of the progressive integration of EU airspace and the legally established conceptualisation of the EU ATM system as a network. Overall, as Table 1 illustrates, the NSDM would facilitate the transition from the current ATM system – characterised by vertically integrated national infrastructure blocks – to a seamless decentralised data management architecture serving the needs of the entire EU ATM network. This shift would also involve creating a market for ATM data services, transforming traditionally monopolistic national infrastructure into competitive market-based activities. Within this framework, the operation of infrastructure may be separated from the provision of air navigation services, thus allowing distributed service providers to deliver services irrespective of national boundaries.

Table 1 – The transformation of traditional ATM (source: Author)



Conventional vertically integrated structures and in-house functions are expected to give way to shared digital infrastructure, a common data layer and a unified data management system, alongside competing providers offering data and information as a service (DaaS, IaaS), software as a service (SaaS), and infrastructure as a service (IaaS), collectively referred to as ATM data services (ADS). In parallel, traditional air navigation services, including aeronautical information services (AIS), communication, navigation and surveillance (CNS) and meteorological services (MET), are also anticipated to transition from national monopolies to the digital marketplace. This evolving, data-centric operational environment – defined by border-agnostic and market-driven service provision – is likely to become a core characteristic of the future EU ATM network. Centralised EU-level functions would support the operation and continued development of the network-wide data management system. While it is considered that the overall improvement of the system would also bring considerable environmental benefits, it is not clear how accommodating increasing traf-

fic levels would lead to a significant reduction of negative externalities such as environmental impact.

A paradigm shift

A paradigm shift may be defined as a fundamental transformation in the foundational logic, rules and operation of a system resulting in new ways of thinking, organising and delivering outcomes. A transition to the new service delivery model would constitute a paradigm shift in Air Traffic Management (ATM). The change would be systemic with EU- and sector-wide implications, as it would alter the underlying logic of the system (from public monopolies to competition), restructure the operational logic (from national airspace-based to network-based) and change the legal standing and roles and responsibilities of the key actors (from public to private). The paradigm shift may be best characterised through its technological, infrastructure, legal and governance aspects.

According to the policy vision, in the emerging new EU ATM paradigm, the technologies employed by different stakeholders will no longer constitute barriers to interoperability. Instead, the technological solutions and concepts defined in the SES policy framework will function as key enablers of interoperability at the network level. The vendor lock-in characteristic of current arrangements will be succeeded by multivendor solutions, thereby fostering greater flexibility and accelerating innovation and system development. Data will be exchanged seamlessly among system participants, thus ensuring that all relevant entities have timely access to the information required for their operations. This transformation is expected to give rise to a new synthesis in infrastructure development. In this paradigm, the entire infrastructure will be optimised and oriented toward supporting a network-level data management system. At the same time, reduction of infrastructure redundancies inherited from legacy arrangements will necessitate implementation of more robust cybersecurity frameworks.

On the operational side, centralised capabilities will enable real-time data analysis, facilitating prompt and informed interventions in traffic management to maintain optimal performance, even in the face of unforeseen events. Furthermore, airspace structures and capacity will be managed dynamically and without regard to national borders, allowing continual adaptation to actual traffic demand. Automation will increasingly be an option.

The new paradigm may also lead to fundamental changes in the legal framework for the provision of ATM. In

the traditional setting, the Chicago Convention has been providing a solid legal foundation for the provision of air navigation services and the operation of vertically integrated national infrastructure blocks in the confines of national borders and airspace volumes. This framework is grounded in the principle of state sovereignty over airspace, in which public authority functions are exercised. With transfer of competences to the EU, the EU is increasingly taking over tasks and power to regulate from its member states. In parallel with the erosion of national airspace sovereignty, especially on the basis of the provision of the SES 2+ Regulation referring to a gradually more integrated EU airspace (Article 1 (1)), the EU arguably has potential to emerge as a new sovereign entity in the aviation domain. Once integration of the airspace over the territory of its member states is fully accomplished, the EU may even become a signatory to the Chicago Convention.

Another fundamental change in the legal framework of the Single European Sky is a transition from a prescriptive obligation-based approach characterised by mandated technological deployment to a vision-based approach. The emphasis is moving from prescriptive rules to soft law, policy documents and collaborative decision-making processes (soft governance). In this developing new legal approach relevant stakeholders approve the vision in working groups with policy documents and collaborative decision-making processes. Consequently, a coordination-driven governance structure is emerging in which traditional state-centric authority is partially supplanted by network-based interactions among public and private actors. Norms and decisions are therefore less frequently imposed by a singular sovereign authority and more often emerge organically with coordinative, multi-stakeholder engagement.

Overall, the paradigm shift involves creation of an entirely new system (new technologies, new infrastructure, a new network-wide data management system, a new market for services, etc.) rather than incrementally reforming the legacy system. The transition produces system-wide impacts at several levels, including technology, infrastructure, operations and the legal framework. New actors and practices emerge, including ATM data service providers, new airspace users, a new governance framework and an increasingly coordinating approach to operations based on real-time analysis of large volumes of data with the potential for automation and real-time interventions.

Is the paradigm-shift likely to happen?

The policy objective of shifting the paradigm to the Digital European Sky and the new service delivery model poses significant challenges for the whole system and for the actors involved. Paradigm shifts may emerge either spontaneously – often driven by technological innovation, such as the disruptive impacts of the internet and digital photography – or with deliberate and coordinated efforts. The Single European Sky initiative seeks to induce such a transformation with structured policy-making and regulatory processes. This is a complex task, which usually involves several components. These include erosion or crisis of the existing paradigm, policy objectives other than a crisis, a new vision, expected benefits, clear allocation of roles and responsibilities, stakeholder engagement and buy-in, strong and consistent leadership, strategic alignment and coordination and robust governance and decision-making frameworks. Additional critical elements include legitimacy, accountability, long-term resource-planning, sustainable funding mechanisms, appropriate incentive structures and effective change management practices. It is also important to recognise that development and implementation of the new system must occur in parallel with continued operation of the legacy system, thus adding further layers of complexity. Table 2 provides an overview of the extent to which these essential components of a paradigm shift are currently present in the Single European Sky framework.

Table 2 – Existence of the necessary components of a paradigm shift in the Single European Sky framework (Source: Author)

Necessary components for a paradigm shift in the SES	Clearly exists	Not entirely clear	Unclear	Missing
Crisis of old paradigm	✓			
Legitimacy	✓			
Policy objectives other than a crisis	✓			
New vision	✓			
Expected benefits	✓			
How the new vision should be achieved (clear allocation of obligations, roles and responsibilities)			✓	
Availability of technologies		✓		
Stakeholder buy-in		✓		
Strong leadership				✓
Strategic alignment and coordination		✓		
Legal certainty, governance/decision-making			✓	
Accountability			✓	
Long-term planning of resource use (including infrastructure development)				✓
Funding and incentives				✓
Change management				✓

The crisis of the existing paradigm may be characterised by persistent operational inefficiencies, in particular inability of the legacy system to accommodate increasing traffic demand from a progressively more diverse set of airspace users, and its limitations in ensuring environmentally sustainable operation of the aviation system. These challenges, together with broad acceptance of the Single European Sky (SES) policy objectives, provide a degree of legitimacy for pursuing a new paradigm.

A wide array of policy objectives have been articulated, many of which are interrelated. These include enhancing operational efficiency and safety, promoting environmental sustainability, advancing digitalisation, fostering airspace integration, introducing elements of marketisation in traditionally state-based functions and developing and strengthening centralised functions at the network level.

Although a long-term vision is described in various policy documents including the Airspace Architecture Study and the ATM Master Plan and it even enjoys broad stakeholder acceptance, the exact method for its realisation is not clearly defined. In particular, the roles and responsibilities of the various stakeholders have not been clearly delineated. Uncertainty also persists regarding the availability of the necessary officially accepted technologies, the distribution of competences between the European Union and the member states, and with respect to leadership and responsibility for managing the transformation process. While formal policy instruments signal support for the envisaged paradigm, stakeholders may interpret the vision differently, and it remains unclear whether their buy-in extends beyond nominal or theoretical endorsement.

This ambiguity may in part be attributed to an absence of strong and consistent leadership and to limited legal certainty in the implementation of policy measures. A lack of strategic alignment and coordination is particularly evident in interactions between public and private actors and in the uncertainties surrounding their roles and responsibilities in shaping the new paradigm. Reliance on soft governance mechanisms coupled with insufficiently specified responsibilities contributes to weakened or no accountability among the entities involved. Moreover, the initiative is characterised by inadequate long-term planning of resource allocation, and by an absence of sustainable funding mechanisms, appropriate incentive structures and effective change management practices.

Under these conditions, stakeholders face multiple and interrelated challenges. These include difficulties in fully comprehending the vision (information and knowledge dimension), in developing sufficient trust to support it (trust dimension) and in demonstrating willingness to relinquish elements of sovereignty or decision-making autonomy (autonomy dimension). In addition, stakeholders must decide whether to commit limited resources to the deployment of new technologies and infrastructure in pursuit of a vision that remains non-binding and uncertain (economic dimension). These challenges are compounded by a need to manage increasing levels of complexity in a rapidly evolving technological and infrastructure environment (complexity dimension) while simultaneously maintaining the operation of an intricate and resource-intensive legacy system as their primary obligation under national and international public law (change management dimension).

The situation may also be conceptualised with three inter-related dilemmas: a sovereignty dilemma, a business dilemma and an autonomy dilemma. The sovereignty dilemma concerns the extent to which states currently responsible for air navigation service provision in their sovereign airspaces and for the operation of the necessary infrastructure are willing to transfer their competences to the EU and accept a model of service provision and infrastructure development which is national-border agnostic and market based. The business dilemma raises the question of the commercial viability of developing products and services aligned with the vision, namely the extent to which market actors may be willing to commit themselves and their resources to realising the vision. Finally, the designated national air navigation service providers face the autonomy dilemma, specifically the extent to which they are prepared to give up certain functions and capabilities, either with centralisation at the network level or by substituting in-house infrastructure, functions and capabilities with services procured with market mechanisms.

Conclusion

While it would be difficult to predict whether and when the transition to the new service delivery model may happen, it is probably reasonable to conclude that its realisation is facing considerable difficulties and will not be a straightforward process. The lack of strategic alignment between public and private interests, the uncertainties surrounding the division of competences between the EU and its member states, the undefined nature of the roles and responsibilities of the stakeholders involved and the lack of a

strong and consistent leadership in policy deployment and change management appear to be particularly significant shortcomings of the current arrangements. Furthermore, it is an open question whether soft governance arrangements will be sufficiently effective to compel stakeholders to direct their actions towards realising the policy vision.

It should also be underlined that the paradigm shift envisioned by the SES policy is not in itself capable of resolving the crisis of the current paradigm. While the reduction of fragmentation by national borders and non-interoperable technologies and the development of a network-wide data management system and centralised network functions could make the system as a whole more efficient, it is unclear how this would resolve the problem of environmental sustainability.

Overall, while the EU ATM sector may be on the verge of a paradigm shift, it is not yet clear if and how the policy vision will be realised. There is a need to address several aspects of policy deployment. Having said that, the question arises of how policy deployment could be improved. First and foremost, uncertainties should be eliminated and long-term planning should be facilitated. Stakeholder engagement and commitment should be strengthened. Clarification of the vision would be beneficial, in particular with respect to strategic alignment between actors and the distribution of roles, responsibilities and functions, including between the EU, its member states and private actors. Phases in the deployment process could be defined in accordance with the availability of technologies and funding. Then, roles and responsibilities and regulatory and governance arrangements may be tailored to each phase. Establishment of a well-defined and appropriately empowered leadership function both for policy deployment and network level change management could provide a strong impetus for realising the vision.

The art of modernising European air traffic management

Andreas Boschen, Executive Director, SESAR Joint Undertaking

Modernising Europe's air traffic management (ATM) is not just about technology, it's about mastering the art of transformation. Just over a year ago, Europe's ATM community agreed on a shared roadmap for the decades ahead. The European ATM Master Plan 2025 sets out a common bold vision: to make Europe the most efficient and environmentally friendly sky to fly in in the world by 2045 while keeping safety as the absolute priority. For many outside the sector, this may sound abstract or distant. However, the plan is not just a statement of intent. Twelve months on, the plan is actively shaping research priorities, investment decisions and the way Europe is preparing its skies for a more complex, digital and sustainable future.



The 2025 edition is the result of extensive stakeholder collaboration and marks an important shift. While earlier versions focused on defining concepts and solutions, this edition has expanded the focus to implementation. In practical terms, this means clearer priorities for development and deployment, stronger alignment with EU climate, competition and transport policies, and a sharper focus on transforming the underlying foundations of ATM.

The transformation outlined in the plan has significant value for the economy and society at large. A more efficient and reliable air transport system will enhance connectivity, thus boosting economic growth and development across the continent. It will also play a key role in the green tran-

sition in the sector. By 2040 there should be a return on investment of EUR 7 for every euro spent and up to 200 million tonnes of CO2 emissions will be saved. By 2050 these figures rise to EUR 17 for every euro spent and up to 400 million tonnes of CO2 emissions saved – equivalent to nearly three years of Europe's total aviation emissions.

The plan is a living roadmap, updated collaboratively by the ATM community to reflect technological progress, policy priorities and operational realities. One year on, progress is already visible in several concrete areas.

Moving the research agenda forward

One of the first tangible signs of implementation was the launch in 2025 of two funding calls (Wave 2) to bolster the SESAR research and innovation project portfolio. Worth several hundred million euros in combined EU and private investment, these calls represent the next wave of research and innovation aligned with the priorities of the Master Plan.

As a result of the Wave 2 calls, 42 new projects have been selected. Running between now and 2028, these projects will focus on advancing digitalisation, automation and sustainability in a coordinated way, targeting areas where progress is needed to unlock system-wide benefits rather



than incremental local gains. They address how to manage increasingly diverse traffic – from conventional aircraft to drones and future air vehicles – in a shared airspace while strengthening system resilience, including cybersecurity and the ability to cope with shocks such as extreme weather, geopolitical disruptions and sudden changes in demand. What is notable is not just the ambition of the Wave 2 projects, but the scale of interest the calls attracted. Record numbers of proposals were submitted, reflecting a shared understanding that the plan provides the reference point for investment and collaboration, and that Europe is moving decisively from ambition to delivery.

The launch of the Wave 2 projects also marks an important transition point for the SESAR programme. The current portfolio of 79 projects will progressively conclude over the next months, paving the way for the new Wave 2 projects.

The outgoing projects are feeding into a pipeline of more than 180 solutions covering all aspects of air traffic management, from airports and airspace operations to network management and supporting infrastructure. Of these, over 130 are already ready for implementation, and 80 have been successfully deployed. These solutions draw on a broad range of technologies, including artificial intelligence, satellite-based capabilities and advanced communications. The projects launched in Wave 2 will not only raise research ideas to higher technological readiness levels but also take forward new solutions in emerging areas. By advancing the most promising solutions, these projects aim to move them to industrialisation and deployment in line with the Master Plan.

Central to this progress are 10 digital sky demonstrators, which have either concluded or are nearing completion. These demonstrators act as precursors to deployment by proving – at scale – that research solutions work in real-world operational environments, while also delivering tangible benefits that pave the way for broader implementation. Looking ahead, further digital sky demonstrators could be launched in 2026, with Wave 3 expected to follow in 2027 under the current multi-annual financial framework.

Transformation in action

The Master Plan identifies 10 strategic deployment objectives (SDOs) to be implemented between now and 2035 to enable deeper and faster changes in the sector, from trajectory-based operations to greater levels of automa-



tion and dynamic airspace configuration. Among them is the new service delivery model (SDO8), which envisages an open cloud-based modular architecture for ATM in Europe, much like the evolution of mobile phones from fixed-function devices in the early 2000s to today's smartphones. Just as today's smartphone technology enables interoperable platforms and third-party apps, this model allows Europe's air navigation service providers (ANSPs) to choose individual services in a multi-vendor environment and to integrate them in their operating environment.

Crucially, the move to the cloud decouples critical ATM services from local site-specific infrastructure, thus opening the door to greater scalability, faster deployment and more consistent service quality across regions. Therefore, resilience is no longer tied to physical installations and continuity of operations is ensured even in the face of local disruptions. Instead of the multi-year timescales that have until now typified the regularity of the update cycle, the new model allows regular updates and patches, a shift that dramatically improves cyber resilience and system integrity. Ultimately, the model lays the groundwork for a collaborative service-oriented approach that mirrors the digital infrastructure already implemented in other safety- and mission-critical sectors like finance and energy. Europe's ATM upgrade is not only essential for its efficiency and security, it is relevant for Europe's sovereignty and technological autonomy.

One year after the adoption of the Master Plan, the service delivery model has become a focal point for collective action. Leading service providers and manufacturers have endorsed the model and work has intensified with stakeholders, in particular with EASA, to ensure that certification and assurance frameworks evolve in step with the technology. This shift matters because it underpins everything else. Without a more flexible and resilient digital backbone, it will be difficult to deploy advanced auto-

mation, integrate new airspace users and quickly respond to emerging threats.

Laying the groundwork for synchronised deployment

The successful roll-out of the new service delivery model and the other strategic deployment objectives outlined in the Master Plan requires a coordinated effort by all stakeholders: ground and airborne manufacturers, end users (ANSP, airports, airspace users), institutional players like the SESAR JU, the Commission, [EASA](#), [EUROCAE](#), EDA and [EUROCONTROL](#). With this in mind, one of the most important steps in the past year has been the start of preparations for a potential Common Project 2.

A Common Project is an EU implementing regulation that mandates the deployment of certain ATM technologies across the EU by a given deadline. The current Common Project 1 (CP1)¹ covers a wide range of areas, such as managing aircraft arrivals more smoothly and boosting airport capacity to reduce delays. The project also focuses on flexible airspace use, including better coordination between civil and military flights, and cross-border free route airspace to optimise flight paths. In addition, it promotes real-time information-sharing and collaborative decision-making across the network, ensuring all actors work from the same up-to-date data. These advances build on the foundation of SESAR solutions, generating operational improvements across Europe's ATM system.

With CP1 regulatory deadlines coming to an end in 2027, a Common Project 2 (CP2) is currently designed to go further by synchronising the deployment of technologies that create even greater impact for the network as a whole. CP2 aims to align air-ground connectivity, ground-based modernisation and the new ATM service delivery model in a cohesive package. This ensures that advances in one area – such as digitalisation or automation – amplify benefits across the entire system, from reduced delays to enhanced sustainability.

The SESAR JU is working with stakeholders to define the scope and content of CP2, with a proposal expected to be submitted to the European Commission in 2026. While the preparatory phase is ongoing, its importance is clear:

¹ [Commission Implementing Regulation \(EU\) 2021/116 of 1 February 2021 on establishment of Common Project One supporting the implementation of the European Air Traffic Management Master Plan provided for in Regulation \(EC\) No 550/2004 of the European Parliament and of the Council, amending Commission Implementing Regulation \(EU\) No 409/2013 and repealing Commission Implementing Regulation \(EU\) No 716/2014 \(Text with EEA relevance\).](#)

CP2 is not just about technology but about orchestrating a synchronised upgrade that ensures Europe's skies remain the most efficient, safe and sustainable in the world.

Beyond synchronised European deployment with CP2, the strategic deployment objectives will also be deployed by other means. They steer local roll-out, allowing solutions to be implemented incrementally to address specific operational or regional needs, and global roll-out, in which international interoperability and alignment are essential. This is particularly the case for trajectory-based operations and future air-ground connectivity, which depend on global standards and worldwide adoption to ensure seamless operations and to fully realise their benefits for airlines, ANSPs and the wider aviation network.

The wider research picture and the next horizon



Progress in the past year has not been limited to ATM. In June, SESAR JU teamed up with the Clean Aviation Joint Undertaking to launch the Aviation Research and Innovation Strategy (ARIS). Presented to stakeholders and the European Commission during the Paris Air Show, ARIS sets out how research and innovation can safeguard Europe's long-term competitiveness, sustainability and strategic autonomy.

Aviation is one of Europe's greatest industrial achievements – a sector that connects people, powers economies and drives technological leadership. It supports 15 million jobs and contributes €1.1 trillion annually to the EU economy. Within the sector, Europe leads the world in air traf-

fic management technologies, with 70% of global airspace managed by European ATM technologies. This leadership is a result of decades of collaboration and sustained investment in innovation by public and private partners.

But imagine a world where Europe no longer leads in aviation and ATM. What would that mean for the flights we take, the jobs in our communities and the technologies that make travel safer and cleaner? With global competitors investing boldly in civil and defence innovation, Europe's aviation sector is under pressure. If we want aviation to remain a strong pillar of Europe's competitiveness and sovereignty, we must act now – with long-term coordinated investment in research and innovation.

ARIS identifies three areas for investment: next-generation aircraft technologies; efficient air traffic management; and cutting-edge enablers such as advanced manufacturing and maintenance, and digitalisation including automation and workforce upskilling. It is estimated that a total funding of €66 billion is needed between 2028 and 2034 – with one-third (€22.5 billion) requested from the EU in dedicated funding and the remainder from member states and the private sector. To put this in perspective, €22.5 billion over seven years represents just 0.13 percent of the EU's annual GDP. This is a modest price for a return on investment that is immense – in skilled jobs and technological leadership, but also critically in meeting Europe's climate goals, securing global competitiveness and reinforcing sovereignty and economic resilience in a rapidly changing world.

The Master Plan and ARIS come at a time when attention is turning to the next EU multiannual financial framework (MFF) for the years 2028-2034. The European Commission has already signalled support for the sector with its listing of “clean and smart aviation” among the proposed moonshots for future research funding.² This commitment is essential if Europe is to safeguard its competitiveness and strategic sovereignty in a rapidly evolving global landscape. The moonshot also sends an important signal by explicitly recognising air traffic management as part of Europe's long-term aviation innovation effort. As the European Parliament and Council are now working intensely on all the proposals for the next MFF, we expect to see good progress and more clarity on crucial issues such as dual use and the link from research to deployment in the course of 2026.

² Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe, the Framework Programme for Research and Innovation, for the period 2028-2034, laying down its rules for participation and dissemination, and repealing Regulation (EU) 2021/695.

We also expect the Commission to propose this year the continuation of Joint Undertakings as a successful means to implement innovation projects by public-private partnerships. [The private members of the SESAR JU have already voiced their availability to continue the partnership.](#)



The coming years will be crucial in delivering on the Master Plan's promises – transforming air traffic management, reducing emissions and maintaining Europe's leadership in aviation innovation. With CP2 on the horizon and ARIS guiding the way, the story of Europe's aviation future is far from over. It is just entering its next ambitious chapter.

More about the [European ATM Master Plan](#)

European ATM in a pivotal moment

Matthias Finger, PhD

The European Air Traffic Management (ATM) system is in a pivotal moment, as it is approaching its limits to be able to cope with growing demand, technological disruption and geopolitical challenges. In 2024 the Commission proposed the SES2+ package, which, among other things, defines network functions and elevates them to the European level. This is a real novelty, and it raises some important challenges. In order to understand and qualify these challenges, I first recall the EU's main actions in matters of furthering a Single European Sky (SES) in the past. I then show how the context has changed since then, notably because of digitalisation, and how the Commission is trying to take account of this changed context in its SES2+ package. Finally, I discuss the two main challenges this raises and argue that these challenges will have to be explicitly addressed if we want to successfully move the SES forward.

The first Single European Sky endeavour (2004): addressing ATM fragmentation

At the very core of the limitations of European ATM is the structure of the European airspace, owing to the attribution of complete and exclusive sovereignty and responsibility over the airspace above its land areas and territorial waters in the Chicago Convention (1944) (Article 1). As Europe is composed of many small countries – 27 in the European Union (EU) alone – its airspace is particularly fragmented and therefore by definition complex to manage, given the high and still growing traffic volumes. In the early 2000s there were over 60 different air traffic control centres (ATCs) operated by national air navigation service providers (ANSPs), which constitute as many different and often incompatible technological systems (vertically integrated national infrastructure blocks). Quite logically, therefore, the first Single European Sky package (SES1) of 2004 was precisely designed to address the technological/infrastructure fragmentation of the European airspace, namely by way of technical standardisation by the EU Aviation Safety Agency (EASA, 2002), and by way of creating so-called functional airspace blocks (FABs).

More concretely, 9 FABs were defined on the basis of the SES1 package (2004) with the aim of integrating airspaces and functions related to air traffic management at the regional level, i.e. across several nation states. FABs were

modelled after today's still only operational example of airspace defragmentation, namely the Maastricht Upper Area Control (MUAC) centre, already created back in 1972 and operated since by EUROCONTROL (an international organisation founded in 1963 and composed of 42 EU and non-EU member states). MUAC provides airspace control over Belgium, the Netherlands, Luxembourg and parts of Germany. However, the FABs are generally considered to have failed and are therefore no longer declared mandatory in the SES2+ package (2024). As a result, European airspace fragmentation along national borders remains today one of the main and so-far unresolved structural limitations of a more efficient and more sustainable SES.

It is also important to mention that airspace fragmentation is not only a national sovereignty issue, since it has also been replicated and institutionalised at the technological/infrastructure level. Monolithic and vertically integrated pieces of national ATM infrastructure have been based on different technologies with limited interoperability and result in vendor lock-in situations creating obstacles to the development of trans-national network infrastructure enabling frictionless operations.

The second SES endeavour (2009): addressing ANSP performance

Five years after SES1, the EU adopted the SES2 package (2009) and tried out a new approach by focussing on, albeit timid, regulation of the performance of the ANSPs, the monopolistic and vertically integrated air traffic management (ATM) service providers. The ANSPs were considered to be like other types of infrastructure managers such as railway infrastructure managers and high-voltage grid operators in the electricity sector, and the EU approached their regulation in a similar manner. More concretely, SES2 was aimed at improving their performance in the areas of cost-efficiency, safety, capacity and the environment. It did so by subjecting ANSPs to EU-wide targets in these four areas, and by requiring newly created national supervisory authorities (NSAs) to establish binding national performance plans consistent with the EU-wide targets. Simultaneously, a performance review body (PRB) was created at the EU level to monitor and assess the performance of the different ANSPs and advise the European Commission (EC) on target-setting. However, the PRB fell short of be-

ing an independent regulator capable of enforcing the performance targets and of sanctioning inefficient operations. Nevertheless, the ANSPs did feel the pressure to meet cost-efficiency targets and responded, among other things, by cutting back on investments in long-term technological innovations and staffing. Overall, the SES2 performance scheme has cemented, rather than alleviated, the ANSPs' national focus and their opportunistic behaviour. Consequently, it did not contribute to the defragmentation of the European airspace as each ANSP was and continues to be busy with its own optimisation. While the SES has to a certain extent reduced ANSP prices charged to airspace users, the current structure and operations of the European Sky still do not allow the same efficiencies as is the case in a centralised system such as the United States.

In 2024 the EU adopted a recast of its different SES endeavours in the form of the so-called SES2+ package. One of the two main areas of attention of this SES2+ package are the shortcomings of the SES2 performance scheme. Therefore, SES2+ strengthens the independence of the NSAs and of the PRB (now standing for the Performance Review 'Board'), just as it strengthens economic regulation more generally. However, this still does not fundamentally alter the underlying problem of EU airspace fragmentation and ANSP behaviour. Quite the opposite. I will therefore not further discuss this track of the EU approach, consisting of further regulating ANSP performance, as I think this will ultimately be a dead end. In addition, in the past 15 years the technological context has radically changed because of pervasive digitalisation.

The changing technological context of digitalisation

Indeed, since SES2 (2009) digitalisation has slowly but surely penetrated ATM and the aviation sector more generally. Consequently, the second area of attention of the SES2+ package is using digitalisation to further the SES. In order to fully appreciate how digitalisation is already and will further be transforming ATM operations, one has to refer to the so-called Airspace Architecture Study (AAS) produced in 2019 by SESAR JU (Single European Sky ATM Research Joint Undertaking). The AAS puts forward a so-called new service delivery model (NSDM), which is said to fundamentally transform the way the national, monopolistic and vertically integrated ANSPs operate, to the point of making them, at least partially, obsolete. The ATM Master Plan (latest edition, 2025) lays out the corresponding roadmap, which will be further concretised in a so-called Common Project (CP) 2 implementing regulation.

In other words, the NSDM tackles the fragmentation of the European airspace head-on, and does this by way of unbundling ANSP operations. There will be, on the one hand, a truly European cloud-computing data infrastructure, whereas, on the other hand, ATM services will be provided by competing and even location-independent ANSPs and by new entrants. In other words, ATM data will become a centralised and probably monopolistic EU-wide infrastructure, whereas ATM service provision will become an EU-wide internal market. As a consequence, ANSPs will be unbundled. On the one hand, their purely infrastructure part will have to be split off and become integrated in a Europe-wide seamless ATM infrastructure, whereas, on the other hand, their service provision part would become subject to competition, i.e. liberalised and regulated accordingly.

In short, ATM will become a liberalised yet regulated network industry at the European level, just like railways and electricity. This will lead to seamless transitions of flights from one control centre to another and trajectory-based operations, cross-border service provision and dynamic airspace management. This, in essence technological, solution if properly implemented and accordingly regulated, will finally achieve the core aim of the EU Single European Sky initiative, i.e. defragmentation of the European sky, along, of course, with increased efficiency, environmental performance and safety. And this is precisely what the European-level so-called network functions are all about.

Evolving network functions and the role of the network manager

Already back in 2009, the SES2 package introduced the concept of network functions. These are critical ATM functions that must be managed centrally at the European level rather than by member states and their ANSPs. The three EU-level network functions identified at that time are air traffic flow and capacity management (ATFCM), balancing demand and capacity, European route network design (ERND), moving towards air routes across Europe, and management of scarce resources, notably radio frequencies and transponder codes. Whereas historically the member states and their ANSPs were responsible for the execution of these network functions, the SES2 package formally established the role of a network manager (NM) to coordinate these three functions at the EU level together with the member states, ANSPs, airports and airspace users in the interest of the overall network. Implementation of these network functions was concretised first in 2011 and

then again in 2019. The role of network manager was assigned by the EU to EUROCONTROL.

15 years later (with the 2024 recast of SES2+), and especially in the light of the transformative potential of digitalisation of ATM operations, the scope and definition of the network functions have been refined and expanded. In addition to air traffic flow management, route design and management of scarce resources, network functions now also include enabling and ensuring data sharing and setting up EU-wide data infrastructure. On the one hand, article 42 obliges ANSPs and others to share real-time data in an interoperable format across the EU and in a non-discriminatory manner, with potential service providers and the NM. On the other hand, article 43 tasks the NM with the creation of EU-wide aeronautical information (data) infrastructure. This obliges ANSPs to adopt interoperable and therefore standardised ATM systems, the data of which will be publicly accessible on a non-discriminatory basis, something which inevitably will have to be regulated at the EU level.

At the same time the role of the network manager has been sharpened. It coordinates execution of the network management functions and monitors their performance and implementation. More concretely, the NM (1) coordinates and supports delivery of ATC capacity, (2) helps coordinate and monitor ATM infrastructure development, yet most importantly (3) it enables data sharing across stakeholders and (4) establishes EU-wide aeronautical data infrastructure.

Intermediate assessment and the way forward

So where do we stand today? We have a performance scheme which is somewhat effective but which by itself does not solve the problem of fragmentation of European airspace, and might even cement it further. We also have rather clearly defined network functions, the governance of which remains torn between national sovereignty and EU authority. We furthermore have a digitalisation dynamic that is driving vertically integrated, publicly owned and monopolistic ANSPs towards being unbundled, if it is not making them obsolete altogether.

Thus, before rushing into more (implementing) regulation, it is in my view necessary to pause and think through the challenges that are raised by the new context of digitalisation. To recall, the initial pre-digitalisation roadmap towards the SES was clear, even though its realisation was up against national sovereignty and vertical integration

of ANSPs and therefore did not progress much. Digitalisation offers new opportunities yet also complexifies not only the future governance of the SES but also the pathway to reach a unified European airspace.

In short, the SES faces some very serious challenges which will first have to be thought through thoroughly and only afterwards can be addressed systematically and comprehensively. This will require an SES3, rather than just a few implementing regulations tweaking SES2+.

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Published four times a year, the Network Industries Quarterly features short (2000-2500 words) analytical articles about these topics in both the industrialised and the emerging countries. It provides original analysis, information and opinions on current issues. Articles address a broad readership made up of university researchers, policy makers, infrastructure operators and infrastructures services providers. Opinions are the sole responsibility of the author(s). Contact info@ic4r.net or fsr.transport@eui.eu to subscribe. Subscription is free.

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ARTICLE PREPARATION

Network Industries Quarterly is a multidisciplinary international publication. Each issue is coordinated by a guest editor, who chooses four to six articles related to the topic chosen. Articles must be high-quality, written in clear, plain language. They should be original papers that will contribute to furthering the knowledge base of network industries policy matters. Articles can refer to theories and, when appropriate, deduce practical applications. Additionally, they can make policy recommendations and deduce management implications.

Detailed guidelines on how to submit the articles and coordinate the issue will be provided to the selected guest editor.

ADDITIONAL INFORMATION

MORE INFORMATION

- network-industries.org
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QUESTIONS / COMMENTS?

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PAST ISSUE

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Shaping the Future of European Rail: Regulation, Digitalisation, and Fair Competition

The European rail sector is experiencing a rapid transformation thanks to digitalisation. At the same time, policymakers and industry stakeholders navigate the challenges of regulation, digitalisation, and fair competition. From redefining ticket distribution and embracing multimodal mobility to ensuring balanced oversight and fostering innovation. These are central themes for shaping the future of rail travel across Europe.