A proposal for the future architecture of the European airspace - At a glance

SESAR
JOINT UNDERTAKING

In 2017, the European Parliament adopted a resolution on the European Commission's "Aviation Strategy for Europe'. The resolution "recalls that airspace is also part of the EU single market, and that any fragmentation resulting from its inefficient use, as well as diverging national practices" causes "longer flight times, delays, extra fuel burn, and higher levels of CO2 emissions". It called on the European Commission to implement the concept of the "European Upper Flight Information Region (EUIR)", as an enabler for the gradual establishment of a "Trans-European Motorway of the Sky". In this context, the European Parliament invited the European Commission to launch a pilot project on the Single European Sky (SES) airspace architecture. The European Commission entrusted the SESAR Joint Undertaking in collaboration with the Network Manager with the preparation, launch and management of such a study stressing the need to ensure consistency with the objectives of the SESAR project and in particular, the vision developed in the European ATM Master Plan. This report summarises at a glance the results and recommendations of the study.

It is important to note that although the study focused on en-route airspace, dependencies with major flows of traffic in and out of airports were duly considered.

Preamble: Towards a Single European Airspace System

When air traffic control centres were first set up within each State, they were built close to the radars or radio antennas, within the line of sight of the flying aircraft. As commercial air traffic grew, the systems used at these centres became more sophisticated thanks to the introduction of electronic assistance technology, and progressive build of flow management capability across European airspace. At the same time, the airspace above the centres was divided into an ever-increasing number of adjacent sectors, so that controllers could manage the aircraft safely at any given time.

The system today still relies on this sectored approach to manage traffic and imposes some limits on the airspace capacity. The airspace is locally optimised according to national needs and preferences, and it is relying mainly on local physical infrastructure. As a result, available capacity in the system is geographically constrained and cannot be activated when and where required to accommodate dynamically the traffic demand. It also means that if one centre has a problem, that problem will inevitably spread. The limits of this architecture were already exposed in the late 1990s.

The Single European Sky initiative was launched with a view to improving the overall performance of air traffic management (ATM) amongst others by moving a number of competences to the framework of the European Union, as part of the Common Transport Policy. New instruments and their legal foundations, such as the Functional Airspace Blocks (FAB), were at that time created as a response to this fragmentation of airspace but in a radically different technology landscape.

The Single European Airspace System proposed in this study is an evolution of the European airspace architecture that leverages modern technologies to decouple the service provision from the local infrastructure. At the same time it increases progressively the level of collaboration and automation support through a data rich and cyber-secured connected ecosystem. Such an evolution opens new business opportunities through creation of a dynamically distributed system, while fully respecting the sovereignty of Member States in relation to their airspace. With this proposal, airspace configuration and design are optimised from a European network point of view, connecting airports and taking due consideration of major traffic flows across Europe. Data services made available to trusted users feed advanced air traffic control tools, allowing operational harmonisation and bringing the level of performance of each control centre to that of today's top 10% -20% performers.

The airspace architecture study proposes a progressive transition strategy towards the Single European Airspace System in three 5 year-periods, while building on known good practices and quick wins, as well as existing initiatives such as SESAR. The aim is to enable progressively additional capacity in order to cope with the significant growth in traffic, while maintaining safety, improving flight efficiency and reducing environmental impact.

- *By 2025, in addition to the already planned roll-out of first SESAR results, new programmes on airspace re-configuration and operational excellence have delivered quick wins. Regulation has evolved to support the transition ahead;*
- *By 2030, the implementation of the next generation of SESAR technologies should be completed with the roll-out of virtualisation techniques and dynamic airspace configuration, supported by the gradual introduction of higher levels of automation support. The new architecture should enable resources (including data) to be shared across the network supporting a flexible and seamless civil/military coordination allowing for more scalable and resilient service delivery to all airspace users;*
- *By 2035, the network should operate at its optimum capability having fully evolved from a system based on punctuality to a system based on predictability across a network that can safely and effectively accommodate 16 million flights (+50% compared to 2017).*

In order to initiate the transition towards a Single European Airspace System, the following three recommendations are made:

- *Launch an airspace re-configuration programme supported by an operational excellence programme to achieve quick wins;*
- *Realise the de-fragmentation of European skies through virtualisation and the free flow of data among trusted users;*
- *Create a legal and financial framework that rewards early movers.*

1 The study re-confirms that without an acceleration of ATM modernisation and complementary changes, the situation of air traffic delays will continue to deteriorate to an unprecedented level

The resumption of strong growth in air traffic is now outpacing the rate of capacity growth and European ATM modernisation. 2018 saw a record 11 million flights, but also severe delays.

Current traffic forecasts indicate sustained traffic growth will continue for the next 17 years. It is estimated that by 2035, there will be an expected 15.7 million flights in the European Civil Aviation Conference (ECAC) region, 5.1 million more than in 2017, or a total increase of 50%. **This creates a major challenge for the ATM industry, which will have to adapt and handle growing traffic safely, efficiently and at an economically acceptable cost.**

Simulations, conducted as part of this study, demonstrate that the capacity crunch that prompted the creation of the SESAR project has returned and highlights the urgent need to accelerate ATM modernisation.

The predicted levels of delays by 2035 are unprecedented and significantly higher than the highest delays ever recorded in the network (5,4 minutes in 1999 during the Kosovo crisis)

Figure 1 Key simulation results reflecting the "as-is" scenario at 2035 horizon

Despite the capacity issue, **it is important to emphasise that the performance levels for safety – which is the core business of ATM – have been remarkable** as highlighted in the latest reports by the Performance Review Body (PRB) and the European Aviation Safety Agency (EASA).

2 This is not a new problem and in the long run it cannot be solved with the same approach as in the past

The current architecture is the result of historical operational and technical evolutions primarily conducted at a national level, which have led to today's fragmented system. Initiatives such as SES and SESAR have led to improved interoperability and harmonisation but have not yet overcome this underlying fragmentation to enable truly seamless airspace operations.

Current architecture

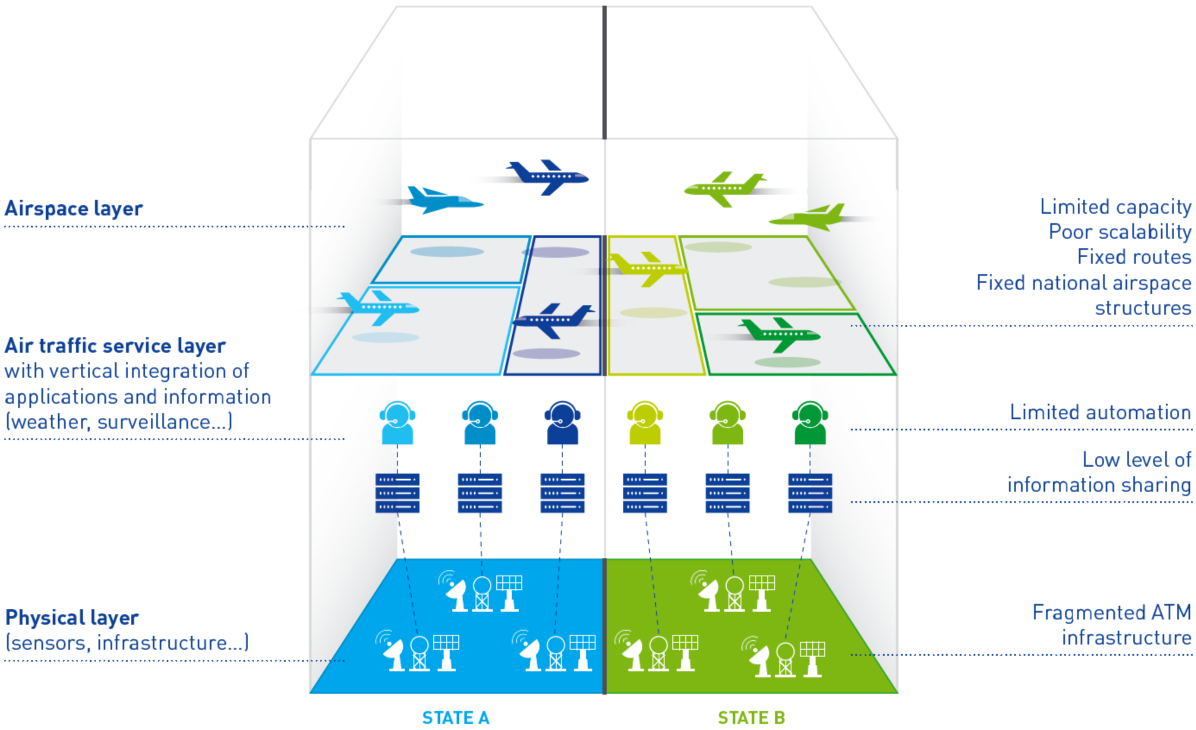

Figure 2 Current Architecture

Each area control centre (ACC) is a node in a global network, some of which are already operating very close to maximum capacity. In the current architecture, resources (including data), and therefore the ability to deliver services, are not connected across those nodes. This fundamentally affects how the network behaves today. It means that if one node has a problem, that problem will spread. The network therefore operates with very little leeway. It does not take much to knock it out of optimal flow. Airspace user try to account for all this by building buffers into the schedule. They still encounter delays, and a newly formed delay for one flight can easily propagate to the second and third flights. Part of it may be absorbed by the buffer, but often not all of it.

The factors within the current architecture that limit overall maximum capacity, as well as the scalability and resilience of the system were identified as part of the study. **Most of these factors are not new and are already known by the industry.** They formed the basis upon which the proposed target architecture was designed.

Factors limiting overall capacity	• Non-optimal organisation of airspace • Limited use of data communications • Limited opportunity to create new sectors • Limited automation support for controllers
Factors limiting capacity scalability and resilience	• Limited predictability • Limited information sharing and interoperability • Limited flexibility in the use of controller resources across ACCs • Geographical constraints on air traffic service provision

3 The proposed problem-solving approach to build a Single European Airspace System that meets the capacity challenge

The objective of this study is to propose a future airspace architecture, and an associated transition strategy, which is robust enough to ensure the safe, seamless and efficient accommodation of all air traffic by 2035. In doing so, it aims to support the further implementation of the SES. The approach of the study is built around several analytical dimensions as illustrated in Figure 3.

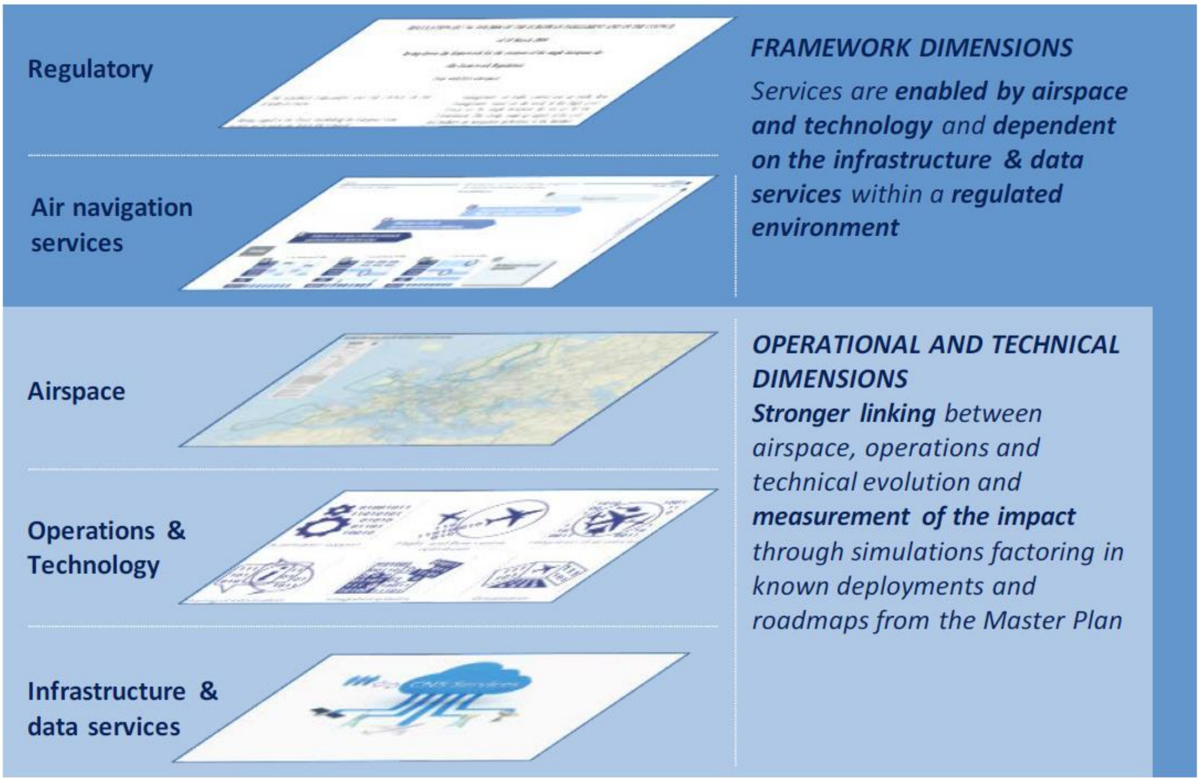

Figure 3. Analytical approach for the study

The focus of the study is the link between the operational and technical dimensions – airspace, operations and technology, infrastructure, applications and data services. The intent is to ensure that airspace is optimised according to operational needs, without being dimensioned by FIR or national boundaries. **It is the first time that such a close linking between all these different dimensions has been undertaken in the context of SES.**

In line with the European ATM Master Plan and the wider EU digitalisation agenda, the deployment of SESAR Solutions in the operational and technical dimensions enables more flexibility and robustness in the airspace dimension than is possible using current technology and procedures**. The relationship between SESAR technology and airspace is key to understanding the proposals in this document and relies on the four-phase approach to improvements already identified in the European ATM Master Plan** (Figure 4).

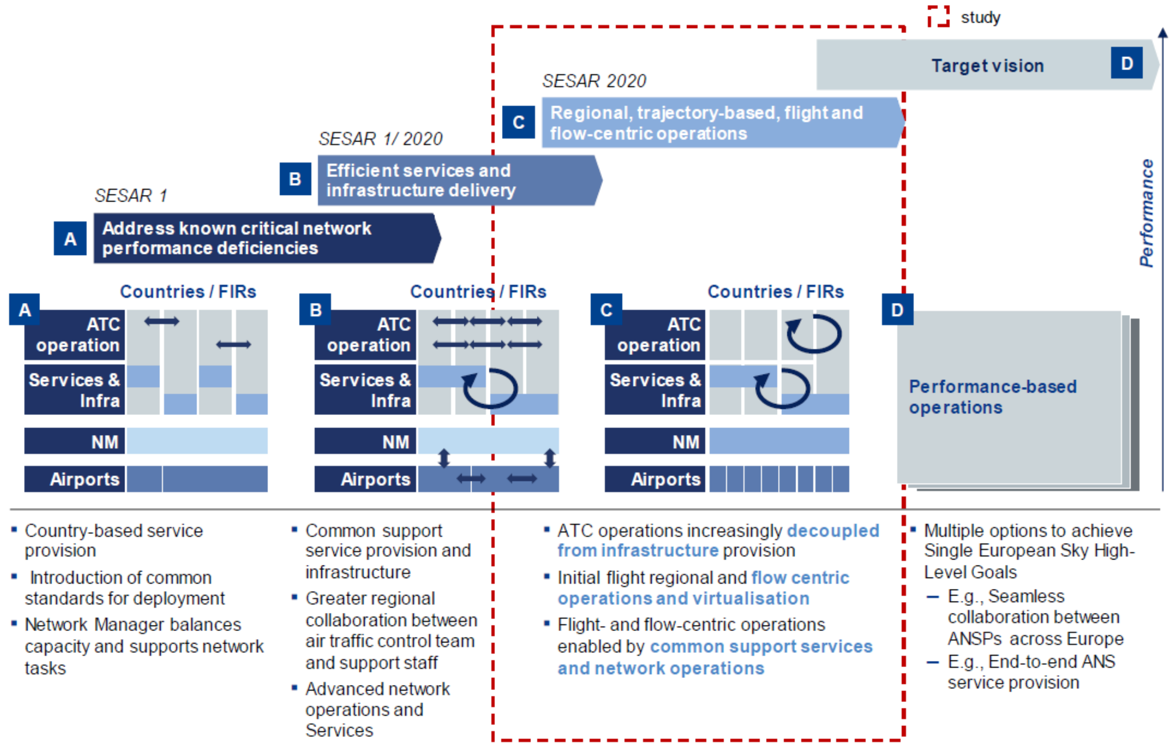

Figure 4. Link between the European ATM Master Plan (2015 edition) and the Airspace Architecture Study

The framework dimensions – service and regulatory – enable the achievement of the proposed architecture. Evolution of these dimensions is closely related to the proposed architecture and the associated potential performance. The study identifies potential issues and implications for these dimensions.

4 The proposed Single European Airspace System is built on optimised airspace organisation, supported by progressively higher levels of automation and common ATM data services to deliver seamless air traffic services

In order to meet the challenges described in the previous section, the progressive implementation of a new architecture is proposed in view of enabling seamless European en-route airspace. This new architecture is captured under the notion of **Single European Airspace System (SEAS)** in which resources are connected and optimised across the network **leveraging modern technology** through a data rich and cyber-secured connected ecosystem. In this environment service providers would be able to collaborate and operate as if they were one organisation with both airspace and service provision optimised according to traffic patterns. This architecture is also more compatible with the overall SESAR vision for a more profound evolution of core air traffic management capabilities driven by new forms of traffic (drones and super-high altitude operations).

A key enabler for the proposed target architecture is the **optimisation of the airspace organisation across the network supported by operational harmonisation where important quick wins can be achieved**. Furthermore, in order to ensure that in the longer term capacity can keep up with demand it is necessary to decouple airspace from service provision to enable new collaborative approaches for the provision of ATM. This new architecture will:

- Deliver an optimised airspace structure, supported by operational harmonisation;
- Enable ATM capacity and scalability to handle all en-route airspace air traffic safely and efficiently, even according to the highest traffic growth forecast or during traffic growth stagnation or downturn;
- Allow all flights to operate along (or at least as close as possible to) user-preferred routing across the entire airspace;
- Promote an optimal use of ATM resources, reducing current inefficiencies and ATM costs for airspace users (AU) and society;
- Increase the overall resilience of the system to all types of incidents, in terms of safety, efficiency and capacity;
- Continue to facilitate the civil and military access to European airspace.

Figure 5 Single European Airspace System

The solutions underpinning the proposed architecture have been grouped into two focus areas addressing respectively two side of the same capacity challenge – capacity and airspace, and scalability and resilience - as presented in Figure 6. Both focus areas are part of the transition from today's operational concept to trajectory-based operations as envisaged by Phase C of the European ATM Master Plan.

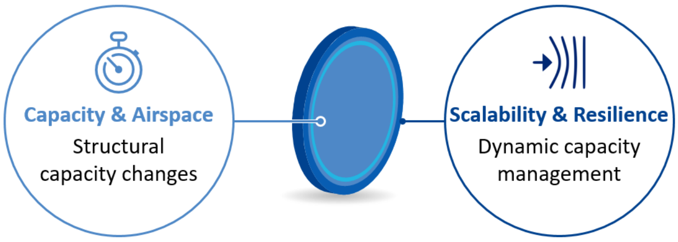

Figure 6. The two sides of the capacity challenge

There are dependencies between most solutions: both advanced airspace concepts and service orientation have a strong link to automation, which in turn requires improved air-ground communications. A more scalable ATM is the result of combining airspace enablers, automation and service orientation.

<table>
<tr>
<td>Focus area 1: Airspace and capacity</td>
<td>
Optimised airspace organisation – Solutions that support improved design and use of airspace.
Operational harmonisation - Aligning the capacity of control centres and ways of working to best practices through systematic operational improvements.
Automation and productivity tools – Increased automation as a progressive enabler of trajectory-based operations (TBO) with short, medium and long-term enhancements to provide increased capacity and predictability.
</td>
<td rowspan="2">Trajectory-based operations to address predictability and collaboration - Deployment of SWIM, 4D trajectory exchange.</td>
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<tr>
<td>Focus area 2: Scalability and resilience</td>
<td>
Virtualisation and ATM data as services - Transition to virtual centres and a common data layer allowing more flexible provision of ATM services.
Dynamic management of airspace – dynamic grouping and de-grouping of sectors and managing the staff resources accordingly.
Flight-centric operations where applicable - Changes the responsibility of controller from controlling a piece of airspace to controlling a number of flights along their trajectories.
Sector-independent ATS operations - Automation support for controllers to enable provision of ATC without the need for sector specific training and rating. Controller training and licensing to be based on traffic complexity, instead of sector specificities.
CNS enhancements - Transition to CNS infrastructure and services concept to support performance based CNS and enable new multi-link air-ground communications environment and continued evolution of the Global Navigation Satellite System (GNSS).
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5 There are conditions to increase the chances of success and in particular to secure the implementation timeline

The new architecture is designed to enable a shift to a new ATM service delivery landscape. The right conditions need to exist to catalyse a reform of service provision in support of this transition. It is important that existing and potential new service providers are treated in a consistent and equitable manner. There are in particular three conditions that should be considered in order to secure the implementation timeline:

- **Capacity-on-demand agreements**: to ensure the continuity of air traffic services by enabling more dynamically a temporary delegation of the provision of air traffic services to an alternate centre with spare capacity.
- **New model for ATM data service provision**: supporting the progressive shift to a new service delivery model for ATM data, through the establishment of dedicated “ATM data service providers” (ADSPs). The ATM data services provide the data and applications required to provide ATS and include flight data processing functions like flight correlation, trajectory prediction, conflict detection and conflict resolution, and arrival management planning. These services rely on underlying integration services for weather, surveillance and aeronautical information. The maximum scope of service delivery by ADSPs covers the ATM data services (such as flight data processing) needed to realise the virtual de-fragmentation of European skies and includes the provision of AIS, MET and CNS services.
- **Targeted incentives for early movers**: specific incentives should be put in place for those actors that implement recommended operational improvements or that shift towards innovative delivery models with a focus on early movers in order to initiate the transition.

6 A possible way forward by bringing progressive transition every 5 years

A successful transition will only be possible through collaboration and commitment from all ATM stakeholders (not only ANSPs). This section is not an attempt to provide a full transition plan (including detailed actions for each stakeholder) but rather to provide an overall transition strategy together with proposed high-level milestones.

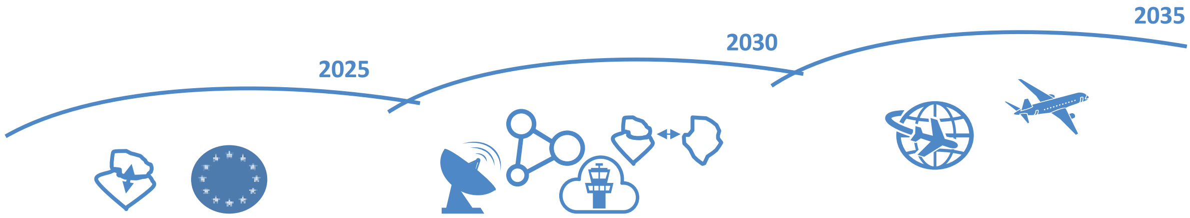
The current regulatory and governance frameworks support the transition in most cases, although refinement might be needed to fully support the proposed changes.

The key enabler for achieving the transition to a service-oriented architecture is the implementation of common attributes on how to manage airspace in common and a common data layer (as outlined previously in Sections 4 and 5. Once established, the architecture will allow different parts of the system to develop at different speeds depending on local needs whilst maintaining an overall coherence and network level.

It is also important to note that whilst the focus of this study is the en-route service, similar considerations are required for terminal services and integrating the airports – the capacity challenge is just as equally urgent in terms of runway capacity.

6.1 The overall transition strategy

The study does not provide a full transition plan (including detailed actions for each stakeholders) but rather an overall transition strategy together with proposed high-level milestones.



- ECAC-wide implementation of **cross-border Free Route, air-ground** and **ground-ground** connectivity
- Launch **airspace re-configuration** supported by **Operational Excellence** Programme
- Set up an **enabling framework** for **ADSP**, **capacity-on-demand** service and **rewards for early movers**, first ADSP is certified

- Implement **virtual centres** and **dynamic airspace configuration** at large scale
- Gradual transition towards **higher levels of automation** supported by SESAR Solutions
- **Capacity-on-demand** arrangements implemented across Europe
- **New ATM Data service provision model** is implemented across Europe

- Transformation to **flight/flow centric operations**
- **Trajectory-based operations**
- **Service-oriented** air traffic management

Figure 7. High-level transition strategy

The key enabler for achieving the transition to the proposed target architecture is the implementation of common attributes on how to manage airspace in common and a common data layer. Once established, the architecture will allow different parts of the system to develop at different speeds depending on local needs whilst maintaining an overall coherence and network level.

Figure 7 illustrates the main elements of each five-year period during the transition. Each element is described in more detail below. It includes an explanation in what way the elements enable for the next milestone.

By 2025

By 2025, the transition strategy promotes both short term initiatives aimed at addressing the capacity issues expected in the coming years, and initiatives to secure the next steps including structural changes expected to be deployed in the next timeframe 2025-2030.

Milestone	High-level description
1. ECAC-wide implementation of cross-border free route, air-ground and ground-ground connectivity	Air-ground data exchange is essential to increase progressively the level of automation of the ATM systems. Ground-ground interoperability and data exchange are critical to defragment the technical dimension of ATM operations, and

	thus to move to the ATM data service provision in a virtual centre context. Consequently, the successful and timely deployment of the PCP shall focus on these functionalities, together with the implementation of cross-border and cross-FIR free route airspace and advanced Flexible Use of Airspace.
2. Complete airspace re-configuration supported by an operational excellence programme to capture quick wins	Launch airspace re-configuration programme by promoting a collaborative process that would involve all relevant stakeholders. This includes an analysis of areas of inefficiencies at network level, validation activities and delivery of an optimised airspace organisation in compliance with agreed airspace design principles, and based on ECAC wide free-route traffic flows. This new initiative would be complemented by an operational excellence programme, which would aim at identifying best practices and capture quick wins (through changes in operational procedures, rostering, smaller adaptations to systems, etc.) among all stakeholders and effectively support their implementation to reduce delays.
3. Set up an enabling framework for ATM data service providers, capacity-on-demand service and rewards for early movers, first ADSP is certified	Provide guidelines and an appropriate legal framework enabling the set-up of ADSP and the capacity-on-demand service. Encourage willingness to implement the new concepts as soon as they are made available.

By 2030

By 2030, the transition to service-orientated architecture is initiated with the implementation of virtual centres providing a better platform for increased interoperability and automation.

Milestone	High-level description
4. Implement virtual centre and dynamic airspace management on a large scale	Building on the new ATM data service provision model, the virtual centre is a key enabler for the resilience of the ATM system. Dynamic management of airspace would already bring benefits when deployed with even more benefits when coupled with optimised airspace organisation and common attributes on how to manage airspace in common. Both SESAR Solutions are expected to be delivered through the SESAR 2020 Programme; their deployment by 2030 is to be secured.
5. Gradual move towards higher levels of automation supported by the implementation of SESAR Solutions	In the context of SESAR 2020, further automation solutions will gradually be made available before 2024. All solutions enabling higher levels of automation will contribute to achieving full trajectory-based operations in the next step.

Milestone	High-level description
	Deployment of these solutions should be incentivised for early movers as referred to in section 5 of this study.
6. Capacity-on-demand arrangements implemented across Europe	Capacity-on-demand is a complementary service enabling solidarity and cooperative mechanisms between Members States and their designated ANSP to provide additional capacity through re-allocation of controller resources and therefore allowing to operate a more resilient and performing aviation system while keeping a network-centric approach. The service relies on the new ATM data service provision model.
7. New ATM data service provision model is implemented across Europe	The need to access to data services supporting the new architecture will lead to the emergence of new actors. ADSPs will in that timeframe play an important role in supporting the transition towards a more resilient ATM system.

By 2035

By 2035, the transition to the service orientated architecture shall be achieved enabling true Trajectory Based Operations and possibly flight centric control where appropriate.

Milestone	High-level description
8. Transformation to flight centric operations where applicable	Gradual implementation of the flight centric concept where applicable and if proven feasible. This concept is subject to the validation of the SESAR Solution known as "flight centred ATC", which will be supported by relevant ATC tools and system adaptations. The on-going R&D activities aim at assessing the feasibility, confirming the benefits expectations and validating the operating environment.
9. Trajectory-based operations	TBO is central to ICAO and SESAR's vision for efficient and safe ATM operations based on the optimised, accurate and constantly updated trajectory. It includes a list of enablers including sharing of information, adapted processes as well as air and ground system adaptations.
10. Service-oriented ATM	Full implementation of the de-coupling of air traffic services, ATM data services, integration services and geographically fixed services. It is inherent to the structural change of the European ATM system to be more flexible and resilience, and allow for scalability.

6.2 The human dimension

A key driver of the proposed target architecture is a gradual evolution towards enabling cross-FIR provision of services (be it within the same State, cross-border or even remote) in a free-route cross border airspace, enabled by a progressive increase of controller support, providing ATCOs with tools freeing them from a number of routine tasks and better supporting their decision-making.

The gradual implementation of the virtualisation of service provision will allow diversification of the controllers’ tasks and the acquisition of new skills. It will also allow closer collaboration between controllers’ teams to address capacity issues. The proposed target architecture enables enhanced collaboration between ANSPs, to bring flexibility to service provision and therefore better align capacity offer to the demand.

The proposed target architecture and associated evolution of service provision will generate changes in the work, skills, and therefore training, of the staff and in particular ATCOs and Air traffic safety electronics personnel (ATSEPs). However, the human will remain at the centre of the system.

From the perspective of professional staff, the main anticipated changes are:

Group	Main changes
ATCO	Greater operational harmonisation across ANSPs, including a transition to TBO will require evolutionary steps towards the new operational concept. This in turn may require a potential re-distribution of roles within the controller team and greater reliance on datalink as the primary (but not sole) means of controller-pilot communications. More fundamental change would occur where Flight Centric operations are adopted, if proven feasible. Once the automation enablers to provide ATC sector independent are in place, ATCO qualifications will be optimised for a higher number of airspace configurations.
ATSEP	Virtualisation and distributed architecture will have a significant effect on the role of the ATSEP. Data and service assurance from third parties will require new monitoring tools and an even greater emphasis on cyber security. The ATSEP role will evolve to acquire new skills and take on these new responsibilities.
AOC and Pilot	Support increased predictability by updating flight plans prior to flight and the agreed reference trajectory.

Implementing the proposed target architecture will only be possible by thoroughly involving staff, as the human is the main actor of any change: full involvement, consultation and buy-in of staff in all the phases of the process (set up of the plan, validation activities, and implementation plan) will be the condition for success.

7 The impact assessment results are sufficient to demonstrate that investing in a solution to the anticipated capacity issues is essential for the future of European aviation

A high level impact assessment was conducted, based on a conservative top-down approach, relying on simulation results from the Network Manager, SESAR validation targets, as well as the overall SESAR performance ambition defined in the European ATM Master Plan to ensure the highest level of consistency.

The table below presents the network performance impact covering the proposed target architecture and associated transition strategy for the following SES key performance areas (KPA): capacity, environment, cost efficiency and safety at the 2035 horizon.

KPA	Performance impact (order of magnitude)
Capacity	Network is able to accommodate 15,7 million flights (increase of 50% in Network throughput compared to 2017) with delays below or at the level of the agreed SES target (max 0,5 min per flight distributed across all flights)
Environment	Between 240 and 450 kg of CO_2 saved on average per flight due to optimisation of trajectories
Cost Efficiency	Between EUR 57-73 saved per flight due to ANS productivity gains
Safety	All simulations have been done against controller workload and indicate that the same safety levels can be maintained

It is important to note that simulation results taken in isolation show an even more promising potential network performance impact **in particular for quick win measures related to airspace re-configuration and operational excellence at the 2025 horizon**.

In terms of economic impact, the assessment indicates a considerable **net benefits potential of between EUR 31 and EUR 40 billion** (or EUR 13-17 billion in NPV) over the 2019-2035 period taking into account related investment needs. Figures are presented in ranges to take into account uncertainty. A sensitivity analysis was conducted to test the robustness of the CBA results under different assumptions (addressing main areas of uncertainty linked to simulation results, traffic forecasts and investment estimations).

Finally, key simulation results from the Network Manager reflecting an “as-is” scenario for 2035 have been compared with the expected performance gains linked to a full implementation of the transition strategy proposed in the study. As illustrated in Figure 8, the full implementation of the transition strategy would bring delays back in line with the SES target (0.5 minutes average en-route delay per flight) while being able to **safely and effectively accommodate 16 million flights** (+50% compared to 2017).

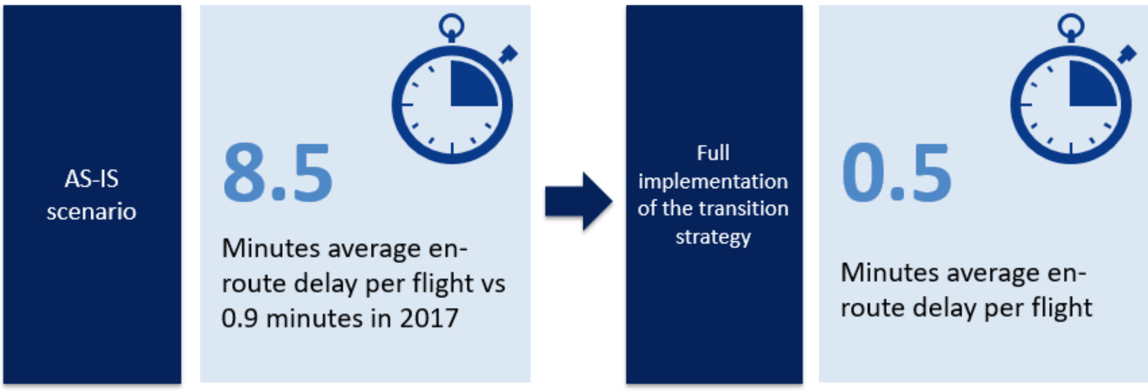


Figure 8 Key delay statistics from simulations conducted by the Network Manager

Taken together, the impact assessment results **are sufficient to demonstrate that investing in a solution to the anticipated capacity issues is essential for the future of European aviation**.

8 In order to initiate the transition towards a Single European Airspace System, three recommendations are made

In order to initiate the transition towards a **Single European Airspace System**, the following three recommendations should be considered by the European Commission.

Firstly, in addition to the timely roll-out of the first SESAR research and development results (Pilot Common Project) there is a pressing need to implement additional measures covering airspace optimisation and operational harmonisation to contain the current capacity crisis and to maximise benefits of technological evolution.

Recommendation 1: Launch airspace re-configuration supported by an operational excellence programme to achieve quick wins
The Commission is invited to consider the following proposals: • Launch an EU-wide airspace re-configuration programme in which the Member States, the Network Manager, air navigation service providers, civil airspace users and military should work together to define and implement an optimal cross-FIR and flow-centric redesign of airspace sectors. This optimised airspace design should be consistent with already agreed-upon design principles at European level. • Launch an EU-wide operational excellence programme in which the Network Manager, air navigation service providers, civil airspace users, military and staff associations should work together to achieve operational harmonisation aligning on air control centres capacity and ways of working to best practices through systematic operational excellence throughout the Network.

Secondly, this study has demonstrated that increased automation and virtualisation hold the greatest promise for enabling a collaborative approach to ensuring higher levels of resilience. This is an important evolution that operational stakeholders and the supply industry have already been partly anticipating in the SESAR project resulting in the emergence of a number of industry-based alliances (grouping of ANSPs with or without manufacturers) irrespective of national borders or FABs. These forms of cooperation should be encouraged, as they are an effective vehicle to realise the vision of the SES.

Recommendation 2: Realise the de-fragmentation of European skies through virtualisation and the free flow of data among trusted users across borders
The Commission is invited to consider the following proposals: • Review policy options which, on their own or in addition to FABs, could effectively deliver a virtual defragmentation of European skies and potentially generate higher levels of resilience by encouraging industry-based alliances to deliver core interoperability through common service delivery. • Implement a certification and economic framework for ATM data services providers taking also into account possible restructuring of ANSP services as well as an EU framework for on-demand cross-border use of services (capacity-on-demand). • Continue to support the timely delivery of SESAR Solutions contributing to the delivery of the proposed target architecture.

Thirdly, based on the analysis conducted in this study, we concluded that certain refinements are necessary to encourage early movers and promote the shift of operational stakeholders towards a service-oriented model supporting true harmonisation of operational concepts and supporting technologies across borders.

Recommendation 3: Create a legal and financial framework that rewards early movers
The Commission is invited to consider reviewing the incentivisation policy to reward actors who are the first to implement the high-level milestones identified in the proposed transition strategy.

9 Limits of the analysis performed

It is recognised that a study of this nature is high level and provides an initial implementation strategy. Detailed work is now needed to build consensus on the technical details of the proposed target architecture and how best to achieve the transition.

The study has the following limits in terms of scope and depth:

- The study does not address all capacity issues as the scope of the study is limited to en-route European airspace. Nevertheless, connectivity between en-route and terminal airspace have been taken into account in the simulations and airspace proposals. As already foreseen in the European ATM Master Plan, other initiatives are required to increase gate-to-gate capacity including resolving issues with airport capacity.
- The study has a 2035 horizon, considering operational and technical concepts and the progress in their delivery (considering different levels of maturity). The simulations and the impact assessment are therefore based on high-level assumptions that must be further validated as concepts mature.
- The reports touches qualitatively upon policy dimensions like performance, safety, cybersecurity, environment, military and governance. However, the simulations and high-level impact assessment primarily focus on quantification of capacity, cost efficiency and environment. They do not provide a full view of the social implications nor of any State-specific impacts.
- The fast-time simulations, which were conducted by the Network Manager to support the study, are based on a high-level re-design of what would be achievable following the timely implementation of the first SESAR R&D results and operational harmonisation. The simulations do not distinguish between performance gains from airspace re-configuration and operational harmonisation.
- The fast-time simulations integrating advanced SESAR Solutions are based on expert judgement of improvements to air traffic controller workload, which have not for all of them yet been subject to validation through real-time simulations. Similarly, the impact assessment is a high-level assessment based on the available data and high-level assumptions consistent with the European ATM Master Plan.
- The study is of a technical nature – it proposes a target architecture. It is recognised that its successful implementation may require changes to the regulatory framework, to be considered by the European Commission and further detailed thereafter.
- While recognising the importance of different types of airspace users, the study focussed on the flexibility required to support all airspace users rather than the detailed specificities for different categories of vehicles, such as drones or business aviation operating in en-route airspace.
- Benchmarking with other regions in the world was excluded from the scope of the study.
- The proposed transition strategy is high level; it does not describe a full roll-out plan, detailing all steps recommended to be undertaken by stakeholders and associated governance. Issues related to regulatory aspects (such as certification, liability, competition and data access) are identified but will require further analysis as the regulatory framework evolves.

