Future architecture of the European airspace

Transition plan

2020

2025

2028

SESAR
JOINT UNDERTAKING

Executive summary

The Airspace Architecture Study was presented at an event organised by the Sky and Space Intergroup of the European Parliament in March 2019, highlighting that, 'without an acceleration of ATM modernisation and complementary changes, the situation of air traffic delays will continue to deteriorate to an unprecedented level'[1]. It proposed a progressive transition strategy towards the Single European Airspace System in three 5-year periods, while building on known best practices and quick wins, as well as existing initiatives such as the Single European Sky ATM (Air Traffic Management) Research (SESAR) Joint Undertaking. The rationale of the study is that, by enabling additional airspace capacity, the air traffic management system will be able to cope with the significant growth in air traffic, while maintaining safety, improving flight efficiency and reducing environmental impact.

Conscious of the urgency to act to address the capacity and resilience challenge, this transition plan identifies three key operational and technical measures that need to be implemented in the very short term (2020 to 2025) in order to set in motion the transformation changes outlined in the Airspace Architecture Study.

These three measures are:

- launch an airspace reconfiguration programme supported by an operational excellence programme to achieve quick wins;
- realise the planned roll-out related to mature SESAR Solutions supporting the implementation of cross-border free-route, air-ground and ground-ground connectivity;
- accelerate market uptake of the next-generation SESAR technologies and services in order to prepare the defragmentation of Europe's skies through virtualisation and the free flow of data among trusted users across borders.

Further to these three measures, which are developed in this document, this transition plan also proposes how the Airspace Architecture Study recommendations can be taken up in existing plans that support the implementation of the Single European Sky. These include the proposed update of the European ATM Master Plan implementation level (Level 3) to ensure that SESAR is fully aligned with the recommendations of the study. An assessment was also done for other key documents surrounding the European ATM Master Plan and supporting its implementation, such as the network strategy plan, the deployment programme, the European plan for Aviation Safety and the European Standards Rolling Development Plan [2].

The implementation of these measures is necessary to address the current capacity challenges with short-term actions and to secure the Airspace Architecture Study implementation timeline. They have to be seen together with the planned setting-up by 2025 of an enabling framework for ATM data service providers (ADSPs), capacity-on-demand services and rewards for early movers, which are not further developed in this plan because they are being progressed directly by European Commission services at the time of writing this report. The successful and timely setting-up of such an enabling framework is a key prerequisite to the successful implementation of this transition plan.

Taken together, the three proposed measures will facilitate putting in motion a successful transition towards a Single European Airspace System that leverages modern technologies. A successful transition will be possible only through strong involvement from Member States, as well as collaboration and commitment from all ATM stakeholders and professional staff. The approach will need to focus on building and maintaining consensus for the transition, including adequate change management and risk management processes.

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[1] Airspace Architecture Study, Executive Summary, https://www.sesarju.eu/node/3253

[2] The Network Strategy Plan is owned by the Network Manager, the Deployment Programme by the SESAR Deployment Manager, the European Plan for Aviation Safety by the European Aviation Safety Agency and the European Standards Rolling Development Plan by the European ATM Standards Coordination Group.

1 Introduction

1.1 Context

The 'proposal for the future architecture of the European airspace' (the Airspace Architecture Study, or AAS) was developed by the Single European Sky ATM (Air Traffic Management) Research Joint Undertaking (SESAR JU) in close coordination with the Network Manager. It reconfirmed that, 'without an acceleration of ATM modernisation and complementary changes, the situation of air traffic delays will continue to deteriorate to an unprecedented level' [3]. In other words, the status quo is not an option.

Handed over to the European Commission [4] on 5 February 2019, the AAS was publicly presented on 5 March 2019 at an event organised by the Sky and Space Intergroup of the European Parliament (SSI) and the Commission services. Since then the AAS has been made public [5]. It contains proposals to address the airspace capacity and resilience challenges, both in the short term and in the medium to long term, by combining airspace configuration changes and new technologies to decouple the service provision from the local infrastructure, by enabling cybersecure data sharing and by progressively increasing the level of automation support.

The conclusions and recommendations of the AAS have been well received by the aviation community, which expressed broad support in principle. In particular, the AAS recommendations were taken on board by the report of the Wise Persons Group on the future of the Single European Sky [6], which was submitted to the Commission in April 2019. The group recommended that a Digital European Sky should

be implemented based on an agreed roadmap, building on the recommendations described in the AAS, and that a new market for ATM data service providers should be created.

In this context, in April 2019 the European Commission asked the SESAR JU, in close cooperation with the Network Manager and Eurocontrol, to develop 'a transition plan regarding the operational and technical dimensions of the target architecture defined in the airspace architecture study'.

In view of the worsening of the capacity situation and the fast-growing flight delays affecting the European network, generating unnecessary extra costs to airlines, negative environmental impact and degradation of passenger experience, the Commission services have recently treated the move towards the implementation of the AAS as urgent and asked the SESAR JU to focus on the actions and programmes that aim to set the proposed AAS transition strategy in motion, with a focus on short-term solutions to the capacity crunch.

1.2 Objectives and scope

The AAS gives a clear overview of the concepts and changes that will allow the building of a more efficient European upper airspace. However, it has not developed a transition plan to move from paper to reality. In addition, the requisite involvement and commitment of different stakeholders and the need to gradually develop towards a cross-border service-oriented approach make it indispensable to have a document that links all aspects and aviation communities.

The Wise Persons Group recommendation No 4 calls for the implementation of 'a Digital European Sky based on an agreed roadmap building on the recommendations described in the Airspace Architecture Study'. It is necessary to provide very short-term answers to the capacity crunch quickly, and the process of selection of the next wave of SESAR research and development (R&D) is ongoing; therefore, the present transition plan is not yet a full implementation plan with associated detailed roadmaps, going all the way up to the com-

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[3] Airspace Architecture Study, Executive Summary, https://www.sesarju.eu/node/3253

[4] Hereafter 'the Commission'.

[5] Airspace Architecture Study, Executive Summary, https://www.sesarju.eu/node/3253

[6] The Wise Persons Group on the future of the Single European Sky was established by the European Commission in 2018 to provide recommendations on the future direction of European air traffic management: https://ec.europa.eu/transport/sites/transport/files/2019-04-report-of-the-wise-persons-group-on-the-future-of-the-single-european-sky.pdf

plete implementation of the intended Single European Airspace System, the end goal of the AAS, with a target date of 2035. For now, it is a plan for how to set the operational and technical dimensions of the AAS in motion, with a focus on the initial set of actions to be undertaken in 2020-2025 and a higher-level view of how to ramp up the R&D needed for full delivery of the AAS recommendations.

The Commission services have taken ownership of addressing the regulatory and service business model aspects of the AAS, which are therefore out of the scope of this technical/operational plan. However, the team working on this technical/operational plan has stayed in periodic and close contact with this parallel work, to allow the good alignment of all dimensions of the AAS's implementation. It should be stressed that the success of the implementation of the present transition plan is subject to the timely and successful conclusion of the work on these regulatory and service business model aspects.

This document thus contains an initial 'transition plan regarding the operational and technical dimensions of the target architecture defined in the airspace architecture study', with a marked focus on short-term implementation measures. It includes airspace reconfiguration considering traffic hot spots and exploiting operational excellence for quick wins (Measure 1), as well as existing SESAR implementation commitments that need to be secured, and sometimes accelerated, during the third reference period (RP3) (Measure 2). As it is already foreseen that the capacity relief from these implementation measures will most likely be exceeded by traffic growth over the next couple of years, the plan also contains a description of the measures that will allow full leverage of digital technologies by accelerating SESAR delivery (Measure 3), thus enabling and supporting the timely transition towards the Single European Airspace System.
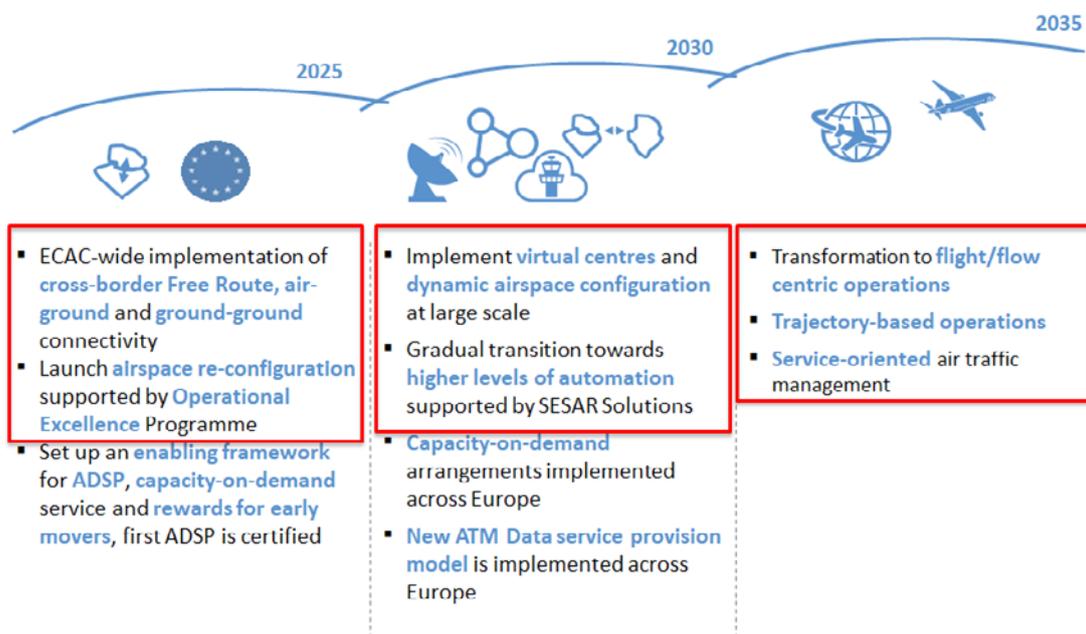

Figure 1: The scope of this operational and technical transition plan in relation to the AAS transition strategy

Each of these measures is further elaborated in the next chapter.

- Measure 1: Launch an airspace reconfiguration programme supported by an operational excellence programme to achieve quick wins.

- Measure 2: Realise planned implementation related to mature SESAR solutions supporting the implementation of cross-border free-route, air-ground and ground-ground connectivity.

- Measure 3: Accelerate market uptake of the next generation of SESAR technologies and services, to prepare the defragmentation of European skies through virtualisation and the free flow of data among trusted users across borders.

The success of this transition plan will be possible only through collaboration and commitment from all ATM stakeholders, including professional staff as well as Member States.

2 Measure 1: Launch an airspace reconfiguration programme supported by an operational excellence programme to achieve quick wins

In 2018, there was an all-time record of 11 011 434 flights in the network, an increase of 3.8 % compared with 2017. En route air traffic flow management (ATFM) delay was 1.73 minutes per flight compared with the EU-wide performance target for the year of 0.5 minutes. It was double the 2017 figure and resulted in a total of 19.1 million minutes of delay. A similar situation is expected for 2019. The capacity performance outlook included in the network operations plan 2019-2024 indicated that capacity performance targets are at stake if urgent structural improvements are not put in place in the short to medium term. Up to 33 air traffic control centres (ACCs) in Europe will not meet the required capacity targets over RP3. As a result, the Network Manager's '7 Measures for 2019'([7]) were agreed to address capacity issues in the short and medium terms. One of the actions included in these measures addresses structural airspace bottlenecks.

This action covering structural airspace bottlenecks indicates that a high number of ACCs have started to show structural sectorisation problems, with a high traffic demand being recorded in elementary sectors. While this was the case for a high number of ACCs in the Functional Airspace Block Europe Central (FABEC) area, similar problems started to appear in central and south-eastern Europe and on the south-west axis. Urgent action is required to start addressing these structural airspace design problems and to avoid their further aggravation in the longer term. To this effect, the Network Manager proposed the creation of three major seamless airspace re-sectorisation projects to be developed on the basis of operational requirements. They were already discussed and agreed in the context of the network collaborative decision-making (CDM) processes and will be executed with the involvement of all the operational stakeholders, with a particular emphasis put on the air navigation service provider's (ANSPs') involvement. This was fully aligned with the short term conclusions of the AAS.

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[7] Network Manager, Eurocontrol, 2019 (https://www.eurocontrol.int/news/seven-measures-counteract-severe-delays)

The development and implementation of those major airspace-restructuring projects is based on existing mature operational concepts — free-route airspace, advanced flexible use of airspace (A-FUA) [8], cooperative traffic management, etc. — and technologies to enable swift development and implementation. Based on the outcome of the Airspace Architecture Study, such airspace-restructuring actions, accompanied by an operational excellence project and supported by the implementation of the technological support set out in the context of the Pilot Common Project (PCP) [9], have the potential to address the considerable challenges of the RP3 performance targets and deliver the required performance by the end of RP3.

High-level description (*)

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-in-class operations and capture quick wins (through changes in operational procedures, operational utilisation of resources, smaller adaptations to systems, etc.) among all stakeholders and effectively support their harmonised implementation to reduce delays.

(*) Extract from the Airspace Architecture Study.

8   The implementation of the A-FUA concept is to be conducted in accordance with the provision of Commission Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace, notably its Article 4, and will require further work on its associated CDM process before implementation.

9   Commission Implementing Regulation (EU) No 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan.

The goal is to take concrete steps for ensuring the defragmentation of the European airspace and the delivery of the required operational benefits. The two programmes will be executed separately, as they involve different operational and technical expertise, but close coordination between the two will be ensured throughout their development and implementation. The two programmes will be implemented gradually and will take into consideration other major projects under development and implementation. The need to progress towards seamless cross-border operations will also address systems' connectivity and interoperability, and improvement of operational procedures.

This milestone is supported by several solutions, enabling the implementation of the ATM functionalities of the PCP (further elaborated by the Deployment Programme and the ATM Master Plan Level 3) that are now in the implementation phase, such as:

- automated support for dynamic sectorisation;

- extended arrival manager (AMAN);

- enhanced demand-capacity-balancing (DCB) tools such as Collaborative NOP (Network Operations Plan), Short-Term ATFM Measures (STAM), traffic complexity and target-time management;

- advanced airspace management (ASM) system including the integration of real-time airspace data and further enhancement of rolling air traffic flow and capacity management (ATFCM) processes and systems.

2.1 Optimised airspace reconfiguration, addressing the hot spots

In the context of the Network Manager's '7 Measures for 2019', the Network Manager initiated an action 'addressing structural airspace bottlenecks'. This action has been tackled in full alignment with the approach defined in the AAS. The approach described below has already been agreed through the network CDM Processes and is in progress in the FABEC area. It will be followed for the other identified hot spots.

It will address, for 2020-2025 a structural approach to airspace sectorisation focusing on a number of hot-spot interfaces as described, at a high level, in Figure 2. The 10 hot spots identified here are numbered only for ease of reference, roughly from west to east, without hierarchy or sense of priority. They are already discussed as part of the action 'addressing structural airspace bottlenecks' included in the Network Manager's '7 Measures for 2019', and based on the current capacity situation in various parts of the network as extensively discussed in the Network CDM process.
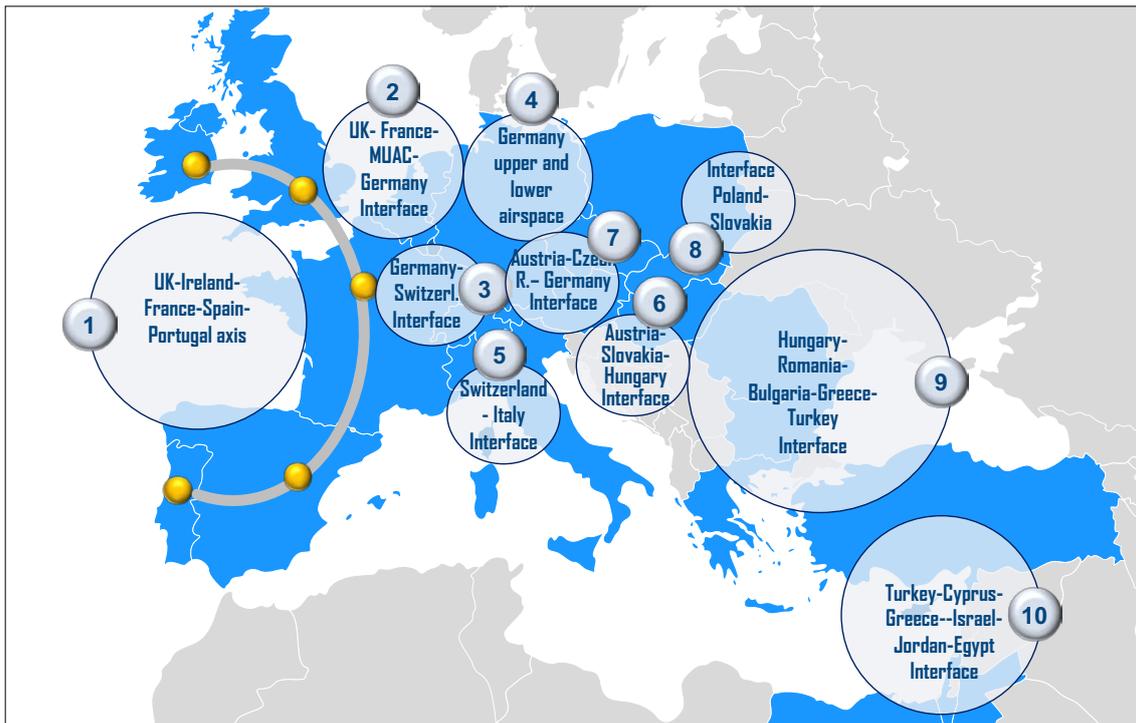
Figure 2: 10 European bottlenecks to address in the short term

The main goal will be the development of an optimised airspace structure, based on cross-border free-route airspace (FRA) and air traffic service (ATS) route network below FRA (if required) with appropriate connections to the terminal manoeuvring areas (TMAs). In the context of the FRA projects, the connectivity to the TMAs (including TMAs covering several airports) represents an important factor for appropriate traffic structuring into, out of and around TMAs. It will include the definition of an optimum sectorisation, together with the identification of the operational resources needed to deliver the required performance.

The main criteria and assumptions used will be the following:

- airspace design criteria as defined in the Network Functions Implementing Regulation (NF IR) ([10]);

- high traffic forecast to ensure sustainable development of the airspace sectorisation;

- capacity and environment/flight efficiency performance;

- for design and operations, European airspace considered as a single airspace;

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[10]   Commission Implementing Regulation of 24 January 2019 laying down detailed rules for the implementation of air traffic management (ATM) network functions and repealing Commission Regulation (EU) No 677/2011.

- FRA cross-border implementation;

- addressing lower and upper airspace and connectivity with the TMAs (including TMAs covering several airports) and continuous climb and descent operations (CCO/CDO), reorganisation of airspace above flight level (FL) 410, reconsideration (if necessary and in cooperation with all operational stakeholders) of the airspace classification (on the basis of the International Civil Aviation Organization (ICAO) classification), gradual integration of new entrants, etc.

- including all the developing civil-military ATM-related requirements and other relevant national requirements;

- alignment with the European Route Network Improvement Plan (ERNIP), Part 1, technical specification for airspace design methodology and requirements.

Detailed implementation projects during RP3 will be derived from and documented in ERNIP Part 2 and will ensure convergence towards the target architecture. They will take into account existing airspace projects that are in process of development and implementation and will address other developments that are urgently required. The implementation roadmap will also take into account local and network priorities, major projects and the RP3 performance plans. The process is planned to be finalised by mid-2020. Quick-win projects will be identified and implemented starting in 2020/2021. All the projects will be run through enhanced Network Manager European Route Network Design (ERND) Function Network CDM processes, involving all operational stakeholders.

Even though this is deemed unlikely, as investments in mature technology required for the transition plan are expected to be found in the RP3 performance plans, Member States may ask for an adjustment of their costs if they deem it necessary to fully implement the transition plan. This is authorised through Article 28(3)(a) of the Performance and Charging Regulation ([11]) without being detrimental to the approved performance targets.

Initiatives for dynamic sectorisation are already taking place, and their potential for broadening could be subject to large-scale demonstrations under SESAR JU auspices.

The existing technical and legal provisions (including the relevant ICAO annexes and the NF IR) allow an expeditious development and implementation process.

The proposed terms of reference of the Airspace Reconfiguration pProgramme, as coordinated by the Network Manager, are included in Appendix E.1.

2.2 Operational excellence programme

In parallel with the development and implementation of the new sectorisation projects that will form part of the airspace reconfiguration programme, an operational excellence programme will be put in place with the aim of identifying and implementing 'best-in-class' operations and delivering minimum common operational capabilities among all stakeholders. This will ensure the achievement of operational and technical harmonisation aligning with best-in-class performance and delivering the expected operational performance in line with the AAS conclusions.

The airspace reconfiguration programme and the operational excellence programme will be addressed separately, as they involve different operational and technical expertise, but close coordination between the two will be ensured throughout their development and implementation.

The topics potentially to be covered could include changes of operational procedures, letters of agreement, application of A-FUA ([12]) and ATFCM, operational utilisation of resources, flight notification and coordination exchanges, harmonised implementation of new operational concepts (cooperative traffic management) and technologies (ICAO Flight and Flow Information for a Collaborative Environment (FF-ICE), system-wide information management (SWIM)), smaller adaptations to systems, systems connectivity and interoperability, reasons for different levels of sectors throughput, etc. The formal and detailed scope of the topics to be covered will be decided jointly and collaboratively by all operational stakeholders.

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[11] Commission Implementing Regulation (EU) 2019/317 of 11 February 2019 laying down a performance and charging scheme in the single European sky and repealing Implementing Regulations (EU) No 390/2013 and (EU) No 391/2013.

[12] A-FUA principles in footnote 5 also apply here.

Detailed implementation projects during RP3 will be derived from and documented in the network operations plan and will ensure convergence towards best-in-class practices. They will take into account existing initiatives that are in process of development and implementation, and will address other developments that are urgently required. The implementation roadmap will also take into account local and network priorities and major projects. The process should be finalised by mid-2020. Quick-win projects will be identified and implemented beginning in 2020/2021. The project will be run through an enhanced Network Manager NOP CDM process involving all operational stakeholders and will coordinate, as required, with the SESAR Deploy-

ment Manager (SDM) with regard to the deployment activities under its responsibility.

Initiatives for quick implementation of more forward-looking concepts will be also identified for implementation or for large-scale demonstrations under SESAR JU auspices.

The existing technical and legal provisions (including the relevant ICAO annexes and the NF IR) allow an expeditious development and implementation process.

The proposed terms of reference of the Operational Excellence Programme, as coordinated by the Network Manager, are included in Appendix E.2.

3 Measure 2: Realise planned implementation related to mature SESAR Solutions supporting the implementation of cross-border free-route, air-ground and ground-ground connectivity

Solutions supporting the implementation of the 2025 milestone identified in the AAS transition strategy (see Figure 1) have reached their necessary operational and technical maturity and are supported by a common agreement for their implementation, as reflected in particular

through existing EU regulations on ATM such as the Pilot Common Project. This measure therefore reflects those implementation activities that are particularly relevant to the implementation of the AAS by 2025.

High-level description

Finalisation of the implementation of cross-border FRA, irrespective of national or flight information region (FIR) boundaries, supported by further progress in the implementation of A-FUA, will provide the airspace structures required to enable efficient and flow-based sectorisation afterwards.

Air-ground data exchange will be 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, at a later stage, to a virtual centre context.

Consequently, the implementation of the required airspace structures in 2020-2025, supported by the successful and timely deployment of several PCP functionalities, will provide the right framework to address sectorisation and operational excellence.

3.1 ECAC-wide cross-border free-route airspace and advanced flexible use of airspace

The implementation of FRA and of A-FUA is already progressing well.

Within the Network Manager's (NM's) geographical area, it is realised through the implementation of PCP ATM functionality 3 (AF3) [13] and relevant deployment programme [14] families, as well as relevant ATM Master Plan Level 3 implementation objectives:

- implementation of FRA, including related system improvements;

- A-FUA and ASM systems (ASM tool, real-time harmonised ASM data exchanges, rolling ASM/ATFCM process, predefined airspace configurations).

- In the SESAR Solutions catalogue [15], FRA is achieved by the following.

- Solution #33: Free route through free routing for flights both in cruise and vertically evolving above a specified flight level. This solution was fully validated by 2015 and was already implemented in a number of ANSPs using flight data-processing (FDP) systems adapted to free-route operations, without either requiring new tools or affecting capacity.

- PJ.06-01: Optimised traffic management to enable free routing in high-complexity and very high-complexity environments. This Solution has addressed the need for new tools in complex environments to support capacity and increased flight/ fuel efficiency. The validation exercises in 2019 have confirmed the feasibility of FRA implementation with the existing systems and tools, and have underlined the additional benefits thanks to the use of enhanced ATC support tools. Cross-border FRA in high-complexity environments is already under implementation.

In addition, FRA implementation adheres to the concept developed as part of ERNIP and related technical specifications for airspace design and airspace management procedures. The coordinated implementation is part of the ERND function of the Network Manager and is based on the airspace design principles included in the NF IR.

The 2019 implementation status of FRA and its planned 2024 implementation status, as currently included in ERNIP Part 2 — ARN (ATS Route Network) Version 2019-2024, are indicated in Figure 3. The detailed planning is included in ERNIP Part 2 — ARN Version 2019-2024, already approved by the Network Management Board.

The FRA implementation to date operates 24 hours a day, with very few areas being time limited, and it went to a very large extent down to TMA levels (including TMAs covering several airports) or to the lowest level of the areas of responsibility of the air traffic control centres concerned. As Figure 3 also indicates, the cross-border implementation has expanded significantly, including in areas with highly complex traffic. In some parts of the airspace where FRA has not been yet implemented, modernisation of local system support is planned to allow its implementation.

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[13] As set out in Commission Implementing Regulation (EU) No 716/2014 of 24 June 2014 on the establishment of the Pilot Common Project.

[14] See Article 11 (1) of Regulation (EU) No 409/2013 on the definition of common projects.

[15] SESAR Solutions Catalogue, 3rd edition, 2019, SESAR JU (https://www.sesarju.eu/sites/default/files/documents/reports/SESAR_Solutions_Catalogue_2019_web.pdf)
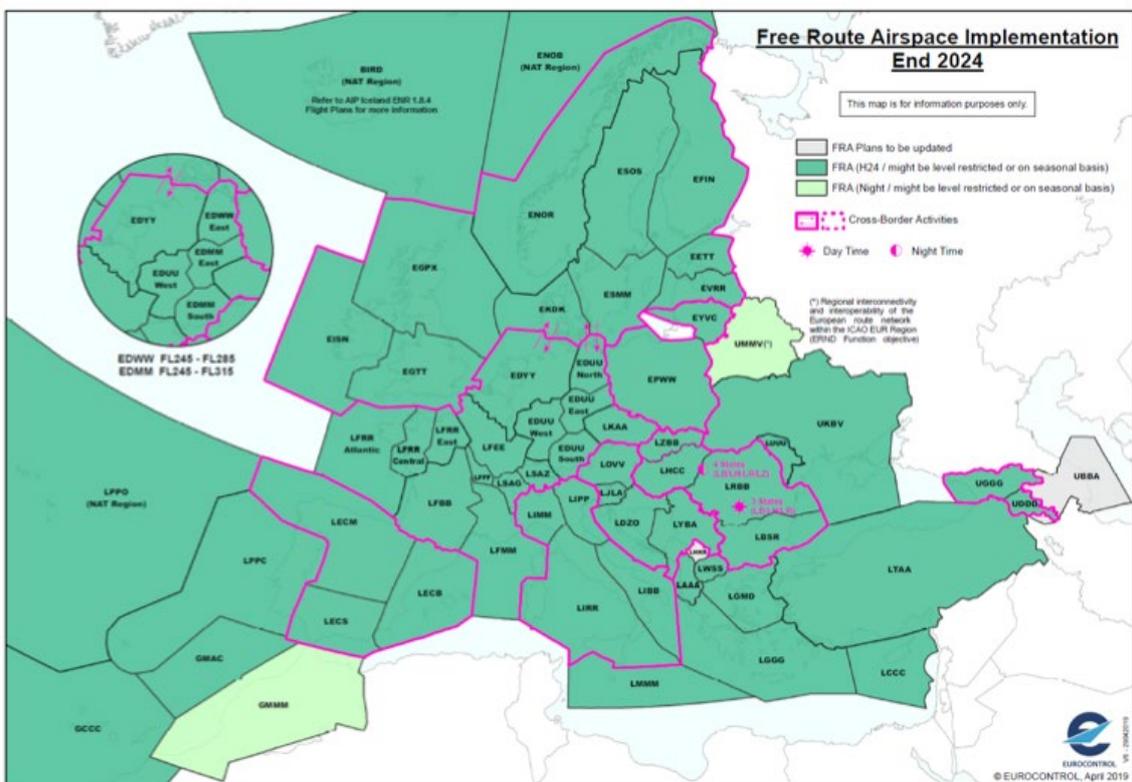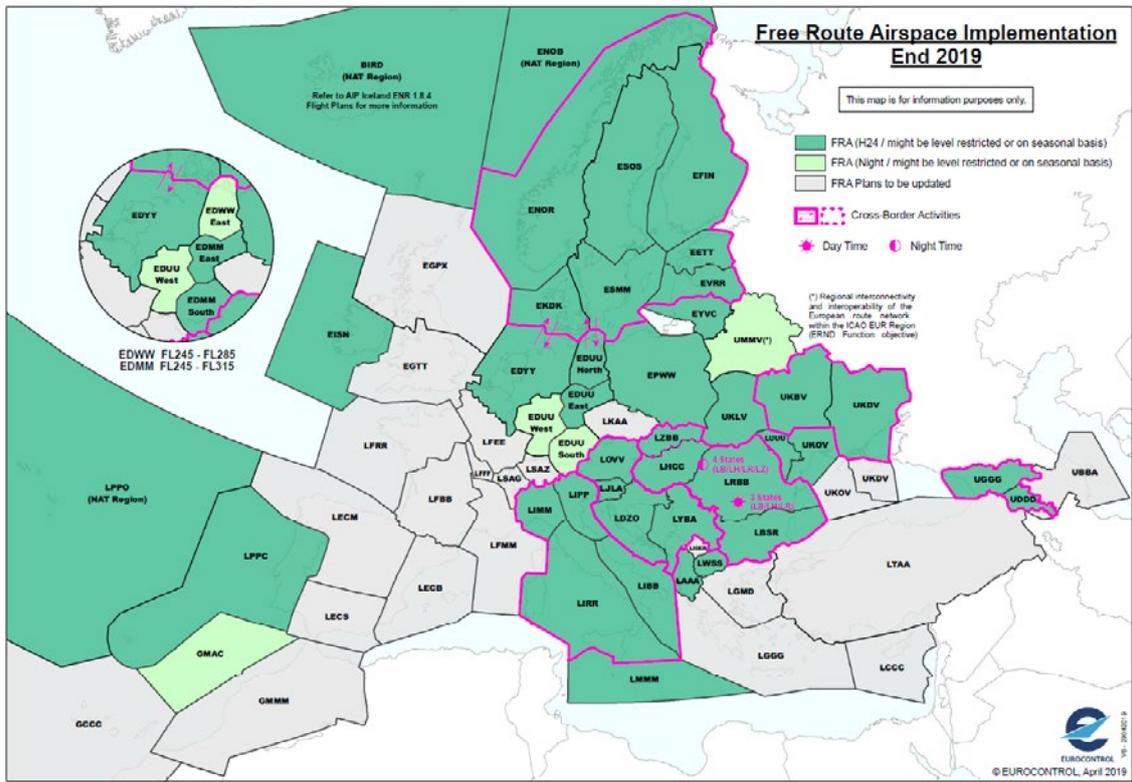
Figure 3: Free-route airspace implementation status at end 2019 and plans till end 2024

While several cross-border FRA projects have been already implemented or are being implemented (BOREALIS, South East Common Sky Initiative Free Route Airspace - SECSI, South East Europe Night Free Route Airspace - SEEN FRA), further efforts will be required over the period 2020-2024/25 to expand FRA's cross-border implementation at pan-European level, to take fully into account the development of airspace structures based on operational requirements and satisfy the needs of major traffic flows. In addition, further adaptation of currently implemented projects will be required to ensure full harmonisation as a major enabler for pan-European cross-border FRA implementation. The implementation of cross-border FRA will also offer better operational options in addressing decongestion of some critical areas of European airspace, especially in high-density areas. That has already been proven in complex areas where cross-border FRA has already been implemented (e.g. SECSI FRA, Italy).

In parallel, all the evolving military requirements will be integrated into the new airspace structure to reflect the new needs expressed by the military users and to ensure a sound civil/military utilisation of the airspace. This also includes separation of air traffic control (ATC) responsibilities between general and operational air traffic, ATC coordination complexity and effort, air defence notification, embargo handling, etc. It will be based on the further progressive implementation of A-FUA, based on the enhanced network CDM processes in cooperation with all stakeholders.

In the SESAR Solutions catalogue, A-FUA is achieved by:

- Solution 31: Advanced flexible use of airspace

- Solution 66: More efficient airspace management

All the developments described above, to be made within the existing relevant regulations [16], will be coordinated between the Network Manager, within the remit of its functions, and all the

operational stakeholders through an enhanced network CDM process, in cooperation with all operational stakeholders [17], and will be documented in ERNIP by mid-2020 with a plan to implement them over the period 2020-2025. The implementation will also continue as part of the PCP implementation coordinated by the SESAR Deployment Manager within the remit of its responsibilities. These developments will include connectivity to TMAs (including TMAs covering several airports) and CCO/CDO operations, re-organisation of airspace above FL410, review (if necessary and in cooperation with all operational stakeholders) of the existing airspace classification (on the basis of the ICAO classification) in some parts of the airspace, gradual integration of new entrants, etc. Regarding A-FUA, the establishment, improvement and implementation of procedures will be done in accordance with Member States' prerogatives defined in the related regulatory framework [18]. Furthermore, the utilisation by general air traffic of available/released 'special use airspace' (civil use of released airspace) must be promoted in order to fully reap the benefits of the flexible use of airspace (FUA) concept.

The existing technical and legal provisions (including the relevant ICAO annexes and the NF IR) allow an expeditious development and implementation process.

3.2 Air-ground and ground-ground connectivity through exchange of digital information

Connectivity through exchange of digital information is needed to enable collaborative management of airspace and remote provision of air traffic services. These functionalities are mature, and planned to be achieved by the timely implementation of objectives defined by different PCP ATM functionalities as well as pre-SESAR implementations. These objectives are documented in the ATM Master Plan Level 3 and the deployment programme, and are already in the implementation pipeline:

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16   In particular, Commission Implementing Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace, and Commission Implementing Regulations (EU) No 716/2014 on the Pilot Common Project and No 2019/123 on the network functions.

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17   This process will respect in particular the needs and responsibilities of the military and secure full accountability and buy-in of all operational stakeholders.

18   In particular, Commission Regulation (EC) No 2150/2005.

- air-ground datalink;

- integration of extended projected profile (EPP) into the ground system;

- new pan-European network services;

- information exchanges using the SWIM Blue Profile (ATC data exchanges for co-ordination and transfer, trajectory management, etc.);

- enhancement of online data interchange (OLDI) messages currently deployed, in a transition phase until full ground-ground interoperability (IOP) implementation (including the exchanges for extended AMAN and notifications/coordination between tower, approach and en route ATS units);

- information exchanges using the SWIM Yellow Profile (aeronautical data, ASM data, extended AMAN data and network-related exchanges);

- interactive rolling NOP data exchanges (occupancy counts and traffic-monitoring volumes, airport operations plan (AOP) / NOP interfaces including API, dynamic sectorisation);

- collaborative flight-planning exchanges related to first system activation (FSA) messages, ATC flight plan proposals (AFPs), slot allocation messages) between ANSPs and NM, and enhanced tactical flow management system flight data (EFD) exchanges to support traffic complexity;

- extended flight plan (eFPL) based on FF-ICE;

- legacy and non-standardised tower/approach/ACC flight data exchanges for notification and coordination purposes;

- operational air traffic (OAT) flight planning.

These functionalities need to ensure the rapid introduction of a secure digital communications backbone that delivers high-performance connectivity for enhanced data exchanges between Network Manager, ANSPs, airspace users and airports. It must also comprise suitable civil-military interoperability elements.

In the same way as an air-ground datalink can reduce voice communication, the automated information exchanges between ground units within the same FIR or across boundaries need to be deployed to reduce telephone coordination and release underlying capacity already available in the ATM system.

This transition plan recognises that the IOP solution is critical to enable the European aviation infrastructure to evolve towards higher levels of interoperability, digitalisation and automation. A first set of IOP functionality ('IOP foundation', including inter-centre mechanisms) has reached maturity in 2019, leading to a restart of the standard update process (Draft ED-133 A) by the end of 2019. The full functionality of the IOP solution will be delivered at V3 maturity in 2020, allowing the completion of an updated Eurocae standard (ED-133) in 2021. The revised flight object IOP standard will form the basis for industrialisation and implementation projects. To avoid a loose patchwork approach and to ensure alignment of national industrialisation and implementation activities, a specific IOP implementation project could be of value. It could become the first building block for full IOP implementation beyond 2025.

The functionalities listed above have been assessed in the AAS as having the potential to deliver concrete operational performance benefits. The implementation will continue as currently planned, with careful and close monitoring to ensure that the appropriate benefits are delivered on time.

To date, data exchange between ATC and the aircraft is based on very high frequency (VHF) datalink mode 2 technology, with performance (latency, bandwidth, etc.) that is not sufficient to support the growing need for ATM air-ground data exchanges in the longer term. Therefore, development of future communication infrastructure will have to be prioritised to achieve the productivity gains and make efficient use of all the other enablers and technologies.

Ground-ground connectivity also enables ATM data service provision, aiming to support remote provision of ATS and the resilience of the network. This concept supports the emergence of new business models with several possibilities, from the status quo to the emergence of a new category of service providers, which may be implemented subject to the outcome of the parallel study undertaken by the Commission services and of the decisions to be taken by regulatory authorities.

4 Measure 3: Accelerate market uptake of the next-generation SESAR technologies and services

The previous two sections (covering Measures 1 and 2) aimed to describe short-term implementation measures considering traffic hot spots and building on known best practices, quick wins and existing SESAR implementation commitments.

However, in 2020-2025, focusing on short-term implementation measures alone will not enable the timely transition towards the target Single European Airspace System that will deliver the ATM performance improvements needed and fully leverage modern technologies such as virtualisation techniques and dynamic airspace configurations, supported by the gradual introduction of higher levels of automation support as illustrated in Figure 4.
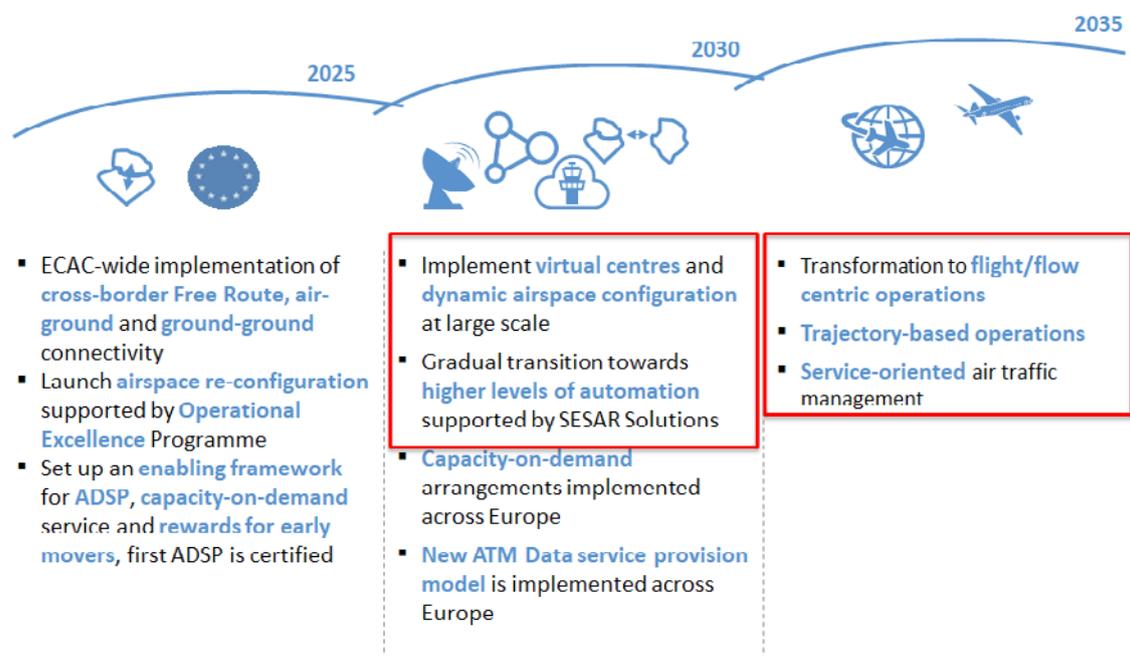
Figure 4: Main technical and operational elements targeted by this measure (framed in red)

This third measure is therefore needed to prepare the defragmentation of European skies, through virtualisation and enabling a free flow of data across borders among trusted users.

To ensure the timely transition, the remaining R&D should be completed (see further details in Appendix F: Link to SESAR Solutions delivery), but the industrialisation phase of the next generation of SESAR technologies and services should also be significantly progressed by 2025, including through standardisation and certification processes involving early movers.

Central to this measure is the proposed gradual implementation of an EU network of large-scale 'digital European sky demonstrators', which must take due consideration of the traffic hot spots outlined previously. This network, tightly connected to standardisation and regulatory activities to fix the industrialisation gap, will be an acceleration platform for a critical mass of

'early movers' representing a minimum of 20 % of the targeted operating environments as defined in the European ATM Master Plan, in order to complete pre-implementation activities and maximise the chances of later market uptake throughout the network, as laid down in the AAS.

Demonstrators will test, in live environments, the concepts, services and technology supporting the achievement of the AAS. This will help build confidence among the supervisory authorities and operational staff by building further performance and safety evidence.
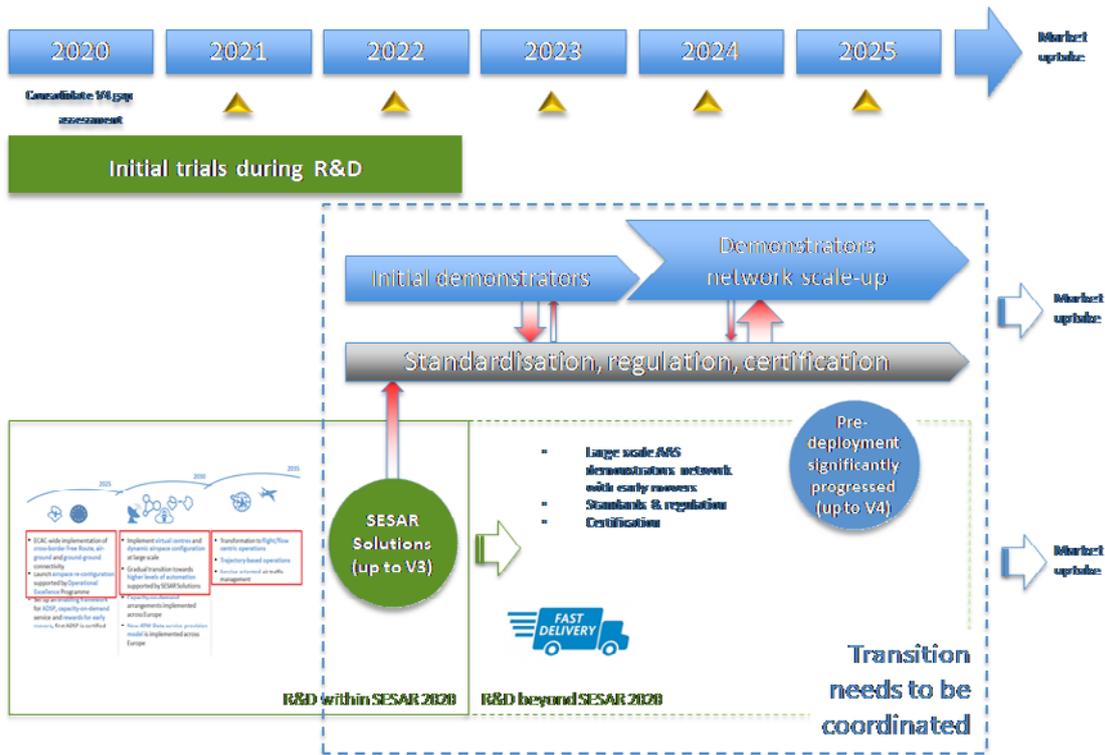
Figure 5: Fixing the industrialisation gap and accelerating market uptake

Once established, this measure will allow different parts of the system to be implemented at different speeds depending on local needs while maintaining overall coherence at network level. Figure 5 illustrates this proposed approach, closing the industrialisation gap and simultaneously accelerating market uptake. Section 4.1 explains the underlying principles.

4.1 Achieving core AAS R&D

The core R&D that underpins the study is fully covered by the SESAR programme. In accordance with Appendix E of the AAS, a gap analysis has been performed to assess the degree of coverage of the scope of the solutions delivered by SESAR R&D against the completed, ongoing, planned and future R&D within SESAR 2020. The outcome of the analysis is shown in Table 1.

Table 1: R&D analysis

Stage	Remarks
Completed R&D	34 % of the required SESAR Solutions have been delivered up to pre-industrial development and integration (V3)
Ongoing and planned R&D	32 % of the required SESAR Solutions are expected to be delivered up to pre-industrial development and integration (V3) at the end of SESAR 2020, i.e. by 2022
	23 % of the required SESAR Solutions are expected to have completed the feasibility research (V2) at the end of SESAR 2020. They will need further validation towards pre-industrial development and integration (V3) beyond 2022
Future R&D	11 % of the required SESAR Solutions have been defined for future research within the existing research programme, with the feasibility research (V2) intended to be complete at the end of SESAR 2020. They will need further validation towards pre-industrial development and integration (V3) beyond 2022

Details of this snapshot ([20]), including the detailed list of Solutions, their planned maturity dates and their links to the AAS milestones, are available in Appendix F.

Figure 6: Delivery of SESAR solutions in support of the AAS

It should be noted that the AAS was limited in scope to focus on the upper airspace only. It is a consistent subset of the European ATM Master Plan, which is leading and structuring European R&D efforts. Consequently, the AAS architecture remains embedded in a bigger development of air traffic management. The overview of the R&D complementary to the AAS is to be found in Appendix F.9.

4.2 Strengthening connections between R&D, standards and regulatory work

In parallel with the standardisation and regulatory activities, industrial systems, operational procedures and advanced services need to be prepared for implementation, and financial investments need to deliver operational benefits and/or returns. ATM and more generally,

[19]   For solutions in the R&D phase, this snapshot presents the expected maturity date based on the best information that is available to the SESAR JU at the time of writing this document

the aeronautics industry participate well in the process of developing standards and making rules. Nevertheless, synchronisation and a coherent approach are necessary to ensure the efficient convergence of regulations and referenced standards and to support acceptable means of compliance, to prevent regulation and standards from lagging behind technology and industrialisation, creating uncertainty and delays. This 'industrialisation gap' is further explained in Appendix A.3.

It is very important to identify the regulatory need for standards on a particular topic as early as possible in the process, remembering that standards not only complement regulations but also provide an important performance reference, supporting industrialisation and implementation. In particular, a robust standards framework will be essential to support the move towards service-based ATM provision, to ensure that performance and safety expectations continue to be met.

The provision of SESAR material as well as the expertise and effort of the SESAR partners is critical in accelerating the standards development timeline. An effective iterative approach between pre-industrial development and integration (V3) and standards development needs to be found. The involvement of the wider ATM industry and other stakeholders through the standards process is necessary and important, as not only the SESAR partners need to implement these solutions.

Once the need for standards and specifications has been identified and the feasibility research (V2) has been completed, then the planning for the pre-industrial development and integration (V3) activities in SESAR should be accompanied by a plan for standards development, as well as the expected interfaces between the two, i.e. provision of draft and final SESAR material, expert involvement, and coordinated planning and decision-making.

The European ATM Standards Coordination Group (EASCG) is a joint coordination and advisory group established in 2015 to coordinate the ATM-related standardisation activities that essentially stem from the European ATM Master Plan, in support of Single European Sky implementation. It has developed and maintains an overarching European ATM standardisation rolling development plan (RDP). The RDP is

based on the standardisation roadmap from the SESAR framework, and inputs on the standardisation plans of its members (including the military) and, where needed, other key players in aviation. The EASCG provides a forum to share and discuss standardisation matters between its members to monitor the development of fit-for-purpose standards.

The standards identified so far are often used as means of compliance with the regulatory requirements. What needs to be considered is the need for standards to support product development and procurement, which are also important for supporting the implementation of SESAR R&D results and enabling accelerated market uptake.

4.3 Accelerating industrialisation and market uptake through a network of 'digital European sky demonstrators'

A key to success is the capability to provide a framework and incentives for stakeholders that whet their appetite to move beyond the pre-industrial development and integration (V3) and to aim for implementation (V5) and operation (V6). The SESAR JU, Eurocontrol, standards development organisations and EASA/EC should therefore cooperate closely for a seamless and coordinated transition between these stages. This would support the development of a stable and predictable performance-based regulatory framework by EASA/EC, and the development of industry standards that will be available in good time. Efficient, effective and lean processes should be used, not compromising in any way the high level of safety and quality the aviation community expects. In this cooperation, the need to develop regulations will be assessed and will follow the regulatory mechanism described above.

To support closing the industrialisation gap, pioneering live operations with early movers should be started, aiming to build consensus and gathering further evidence to determine if regulation (or amendment of existing regulations) is required. Periodic gap assessments should be performed to trigger specific actions (research, regulation, standardisation or demonstration).

Consequently, central to the proposed measure is the gradual establishment and scale-up of a network of digital European sky demonstrators, targeting early movers to accelerate SESAR delivery. The network should become a forum to share knowledge on how to accelerate the transition towards a Single European Airspace System that fully leverages modern technologies. It will focus on 'flagships' representing breakthrough technologies, starting with a focus on virtual centres, dynamic airspace configuration and solutions boosting automation support that are nearing maturity. Using the early movers'

industrialised platforms (integrated with their operational systems) will help to strengthen the business case and is expected to increase the buy-in from the community, sparking the interest of stakeholders that were not involved in the earlier R&D. Thanks to this measure, all players, including competent regulatory authorities, can mutually learn and exchange practical expertise related to the introduction of the next generation of SESAR technologies. Synergies with the newly established airspace reconfiguration and operational excellence programmes will also be sought.
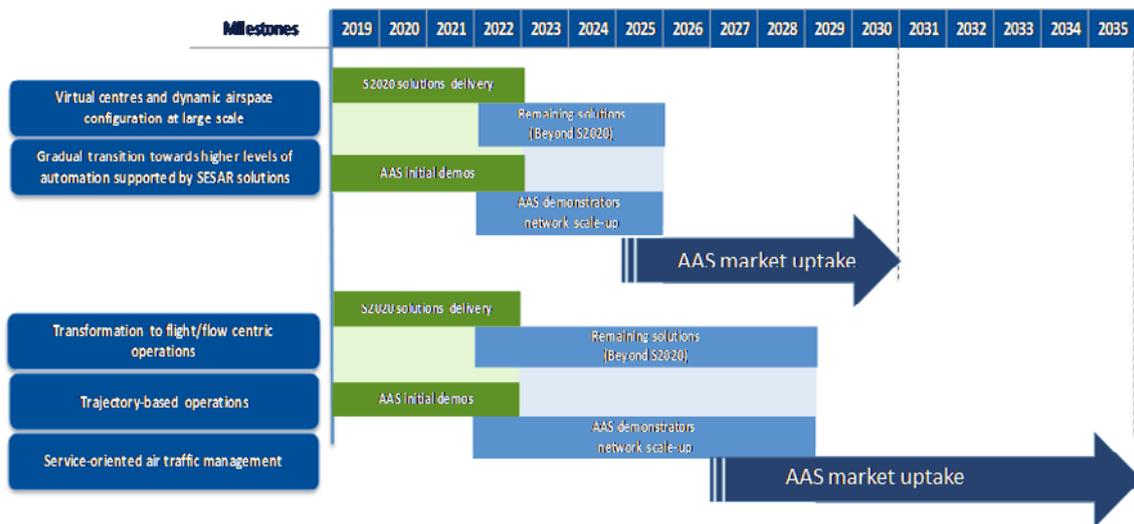
Figure 7: Roadmap: the gradual scale-up of a digital European sky demonstrators network (indicative)

5 Dependencies on actions within and outside the scope of this transition plan

The Europe-wide harmonised implementation of the AAS architecture requires many actions from many participants. The envisaged end result can be achieved only if all actions are taken in the right order. Not only is synchronisation between regulatory and technical/operational development key, but also interdependencies between various actions need to be respected within the technical/operational development.

The scope of this transition plan is limited to the technical and operational aspects. In parallel, regulatory aspects will be addressed under the direct responsibility of the Commission services. This is illustrated in Figure 8.
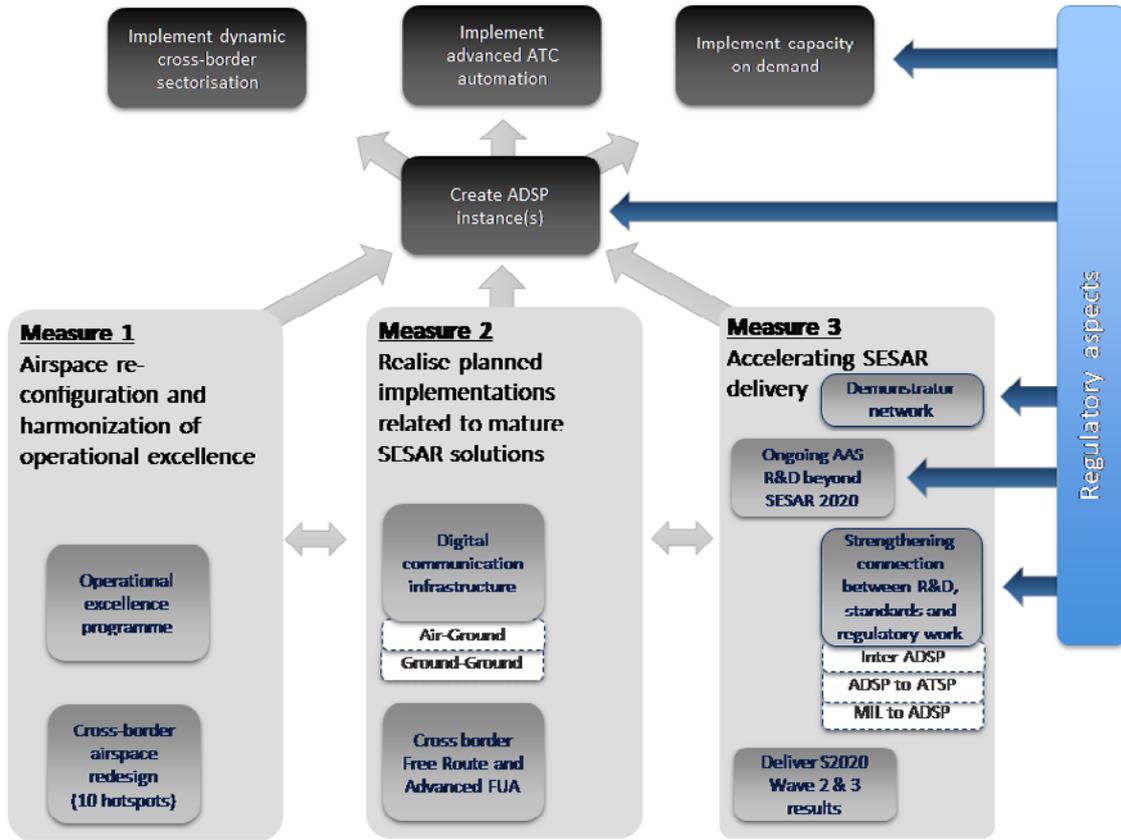
Figure 8: A coherent stepwise transition

Once all measures are in place, the Europe-wide implementation of fully interoperable air traffic management data service providers (ADSPs) is enabled. The result is a potentially substantial reduction in the number of different FDP systems, making the last technical and operational innovation actions much more cost-efficient than the fragmented situation we have today, and facilitating the implementation of:

- advanced ATC automation
- dynamic cross-border sectorisation
- capacity on demand.

The proposed lines of actions and decisions depicted in the three measures depend on a number of prerequisites related to the regulatory framework and aspects of service provision, which need to be addressed at European level.

The key dependencies are the following:

- appropriate decisions taken on the implementation of Measure 3, affecting actions beyond the current SESAR 2020 programme, with particular attention to governance and funding arrangements;
- the timely set-up of an enabling framework for ADSPs and capacity-on-demand services, focusing on incentivisation, including rewards for early movers, charging and certification;
- the timely set-up of an appropriate management process (including, for example, the designation of a project manager), without which potential risk could be incurred, resulting in the suboptimal achievement of the transition plan.

Details on these dependencies and risk will be found in Appendix A.6 and Appendix B respectively.

Appendix A: **Roadmaps**

A.1 Overall logic

Figure 9 is a simplified illustration of the overall logic for new actions to be undertaken to set the implementation of the AAS in motion. It emphasises that, in addition to the critical implementation for mature SESAR Solutions and prerequisites (Measure 2), a strong coupling between airspace design and technological enablers should be achieved by capturing synergies between the proposed implementation of the new programmes (Measure 1) and the launch of a network of demonstrators to accelerate market uptake (Measure 3).
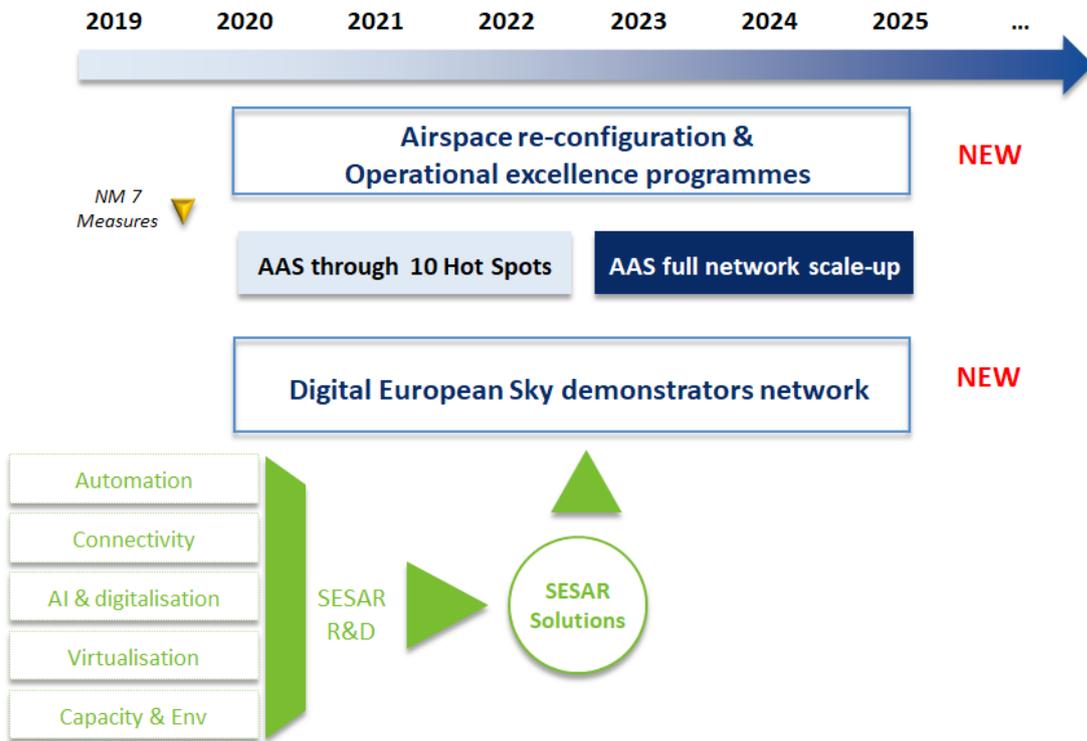
Figure 9: Roadmaps: the overall logic

A.2 Short-term implementation measures addressing hot spots

Measure 1 of this transition plan requires that a number of short-term measures be implemented, first focusing on the hot spots identified as requiring immediate action, but also throughout the entire ECAC European airspace, the final implementation deadline being 2025. These measures have to be seen together with the planned roll-out of mature SESAR Solutions identified in the European ATM Master Plan in the period 2020-25 (Measure 2), all of which have well defined roadmaps and implementation milestones.

Table 2: Short-term implementation measures roadmap

When	What	How
2019	NM and operational stakeholders best efforts on '7 Measures for 2019'	NM prepares to launch an EU-wide airspace reconfiguration and operational excellence programme with an initial focus on 10 hot spots
2020	NM and operational stakeholders — initial delivery of airspace reconfiguration and operational excellence programme in 10 hot spots	NM to launch and monitor with ANSPs, addressing measures related to airspace design and operational excellence
2021	NM and operational stakeholders —airspace reconfiguration and operational excellence programme in 10 hot spots — delivery	NM continues and monitors the initiatives with ANSPs, addressing measures related to airspace design and operational excellence
2022	NM and operational stakeholders — airspace reconfiguration and operational excellence programme at network level — initial delivery	NM continues and monitors the initiatives with ANSPs, addressing measures related to airspace design and operational excellence, with enhanced focus on cross-border implementation
2023	NM and operational stakeholders — airspace reconfiguration and operational excellence programme at network level — delivery	NM continues and monitors the initiatives with ANSPs, addressing measures related to airspace design and operational excellence, with enhanced focus on cross-border implementation
2024/2025	NM and operational stakeholders — airspace reconfiguration and operational excellence programme at network level — delivery NM and operational stakeholders — dynamic airspace management with virtualised network platforms initial implementation	Finalisation of the airspace reconfiguration programme and operational excellence projects; NM initiates dynamic airspace management with virtualised platforms

A.3 The industrialisation gap

Successful development of a system depends on implementing adequate methods to ensure that the planned system is achievable and will be fit for purpose.

The European Operational Concept Validation Methodology (E-OCVM) is applied in the European ATM R&D collaborative projects. It provides a common reference for the assessment of concept maturity and the management of concept development transitions from R&D through industrialisation to implementation. Figure 10 provides an overview of the whole life cycle of ATM concepts.
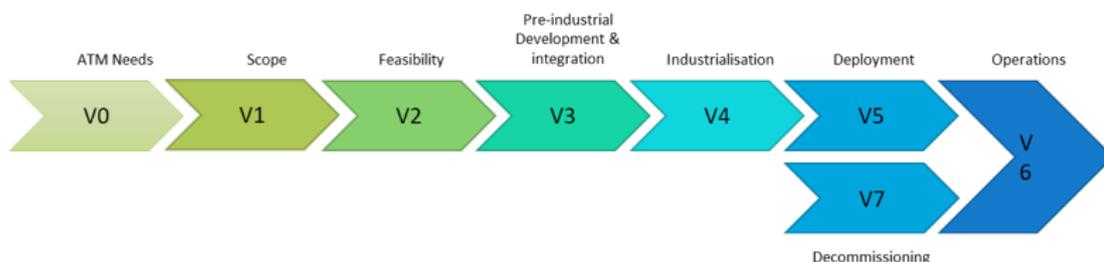

Figure 10: The E-OCVM life cycle

Currently SESAR solutions are handed over to the industry at a V3 maturity level. The handover material, used to make decisions concerning transition to implementation, is essentially composed of a set of operational and technical requirements, including their validation results, covering, for example, performance assessments.

At this stage of maturity, validations are performed by a representative but limited group of stakeholders in an environment that is as close as possible to real operational environments: simulations and shadow mode operations, relying on pre-industrial prototypes.

V4 is an essential phase in the SESAR innovation cycle, which lies between the end of research and the start of larger-scale implementation.

One of the most critical aspects of the V4 phase is the development of mature and robust standards that will both support the industrialisation of the systems, procedures or services in question and provide the basis for means of compliance with any necessary regulations.

Aviation standardisation has a history of delivering high-quality material through a consensus-based process; however, in some cases this can take some time to complete. The increased pace of technological change and the need to deliver timely solutions to ATM performance issues make it necessary to streamline the processes and procedures as well as the handover between different stages described above.

What complicates the V4 phase is that, parallel to the standardisation and regulatory activities, industrial systems and operational procedures need to be prepared for implementation, and financial investments need to deliver operational benefits and/or returns. Normally the industry participates well in the process of developing standards and making rules. Nevertheless, synchronisation and a coherent approach are necessary to ensure the efficient convergence of regulations and referenced standards and to support acceptable means of compliance, to prevent a situation where regulation and standards from lagging behind industrialisation.

Nevertheless, one needs to recognise that each specific implementation project may follow specific implementation strategies: some may not (yet) be subject to detailed implementation regulations; standardisation may follow limited implementations or become essential, depending on the scale of implementation. Beyond regulations, standards, procedures or reference material, industrial and operational stakeholders will need to perform their specific business assessment prior to the implementation of products and services. The variability between stakeholder business

cases and any associated risks will also entail challenges for industrialisation.

Example

Once SESAR R&D allows the delivery of solutions at maturity level V3, the airborne industry has to decide whether or not to adopt them (V4). At this stage, airspace users do not commit to buying the airborne Solution, and this launch decision for system development is taken by the airframers and their suppliers on their own, based on a business case built with the best understanding of market penetration and operational benefits for airspace users.

More specifically, some SESAR Solutions that require heavy infrastructure synchronisation and have reached R&D maturity may face the challenge of a lack of early adopters as well as a lack of synchronisation of investments across national boundaries. At the core of the issue is the lack of pan-European leadership on investment decision-making, which continues to be at national level.

The absence of a structured approach to close this maturity gap represents a high risk to the implementation of the AAS. It is therefore essential that organisations in charge of European ATM developments work closely together and secure this V4 industrialisation phase to enable a seamless transition between R&D and implementation.

A.4 Accelerating SESAR market uptake

The short-term measures described above are necessary, first, to provide an effective answer to the current capacity shortage, but also to gain time to allow R&D and pre-implementation activities to be intensified and accelerated as much as possible to bring longer-term and structural solutions that will effectively deliver, by the 2030 and 2035 target milestones, the recommendations of the AAS and the target Single European Airspace System. This intensification of R&D and acceleration of SESAR market uptake are synthesised in Table 3.

Table 3: Roadmap for accelerating SESAR delivery

When	What	How	
2020	• Initial demos are launched, focusing on most mature SESAR solutions and considering hot spots • Consolidation of V4 gap assessment	SESAR 2020	**First Digital European Sky demonstrators**
2021	• Run initial demos	SESAR 2020	
2022	• Consolidated delivery of SESAR 2020 solutions related to AAS	SESAR 2020	
	• Consolidated results of the initial demos launched	SESAR 2020	
	• Launch EU network of digital European sky demonstrators	TBC	
2023	• Run EU network of digital European sky demonstrators	TBC	
2024	• Run EU network of digital European sky demonstrators	TBC	
2025	• Consolidation of results	TBC	

(Left vertical label spanning 2021–2025: Enhanced coordination of the industrialisation processes to advance solutions more rapidly through standardisation and certification)

A.5 Success criteria for this transition plan

- All stakeholders, including States, express clear ownership of and commitment to the proposed transition measures outlined in this report. It is vital to identify the likely impact on stakeholders from the start of executing the transition plan, especially for the military community, whose level of support to the plan's execution will depend very much on that impact.

- The target architecture and conclusions of the AAS are fully respected.

- Transition measures are prioritised with an explicit focus on setting the AAS in motion in the short term (2020-2025) to address the current and growing capacity issue, in particular in relation to identified hot spots. Measures that are already ongoing are duly reflected, and additional measures that are deemed necessary are highlighted.

- It is assumed that enabling regulatory frameworks for ADSP, capacity-on-demand service and rewards for early movers, which are part of the recommendations of the AAS, will all be fully implemented in 2025.

A.6 Transition logic and dependency between the measures

This transition logic brings together various considerations related to, for example, technical and operational dependencies between changes, business cases, time to deployable maturity and transformation risks. Even though the exact transition schedule may evolve over time, it is expected that this transition logic will remain valid in most cases.

Figure 8 has been refined into Figure 11 to indicate all the interdependencies ([20]) between the actions. Each interdependency is visualised through lines between the actions that are explained below. A provisional outcome of the regulatory aspects is included to clarify the interdependencies between the operational/technical aspects and the regulatory aspects.

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[20] Rectangles represent actions. Lines represent interdependencies. Sequential relations are shown by single-headed arrows, whereas bi-directional arrows show parallel coordinated actions.
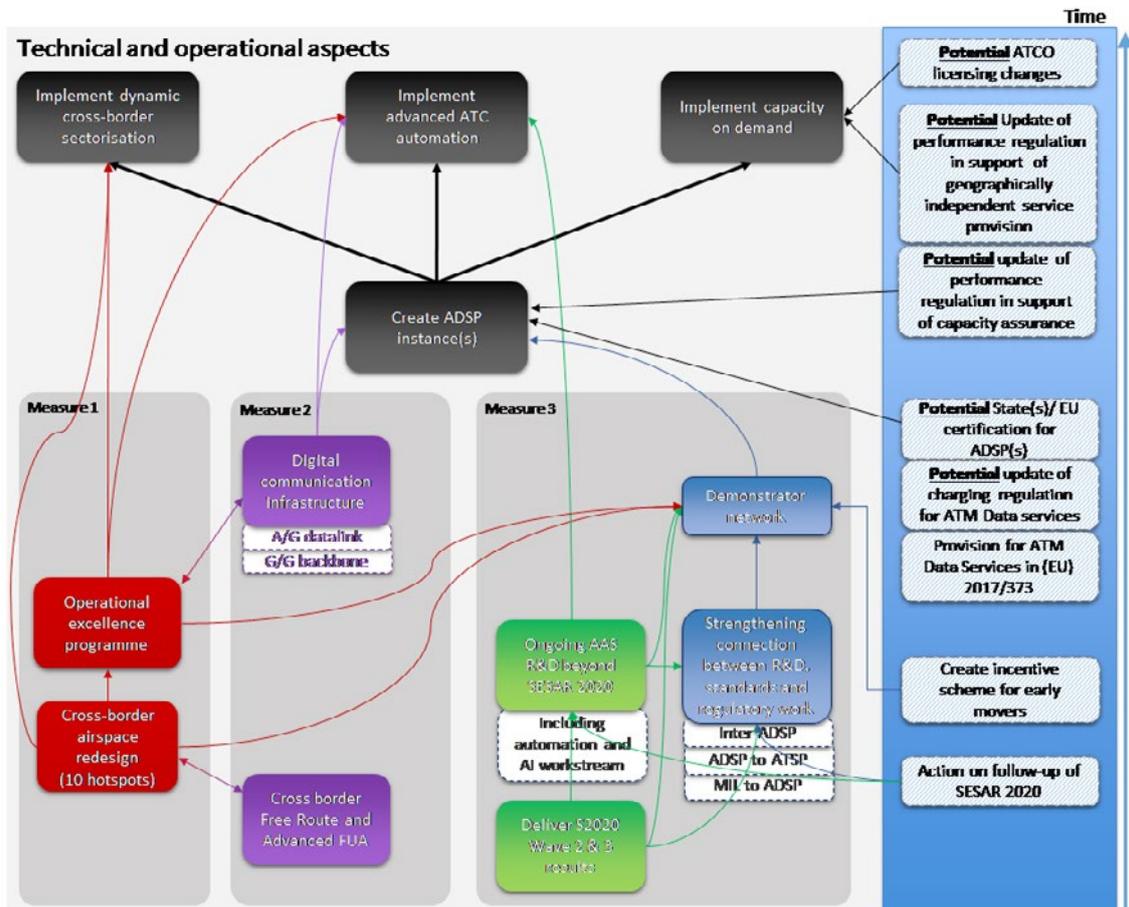
Figure 11: Detailed interdependencies

Measure 1 consists of cross-border airspace redesign and the operational excellence pro-gramme. The following interdependencies exist.

- The creation of a seamless cross-FIR FRA for the whole ECAC region will al-low airspace users to fly their preferred route across the entire ECAC airspace without intermediate entry and/or exit at FIR boundaries. This changes the op-erational requirements (traffic patterns, bottlenecks and hot spots) that drive airspace design. Starting with already existing structural sectorisation prob-lems, it is necessary to synchronise the free-route and A-FUA implementation and the redesign of sectors in support of these evolving operational requirements.

- Early demonstrations of cross-border dynamic sectorisation through the crea-tion of a network of digital European sky

demonstrators can be made only once the ANSPs involved have redesigned their airspace to define cross-border dynamic sectors, as part of the bigger programme of cross-border airspace redesign.

- Early demonstrations of ADSPs through the creation of a network of digital Eu-ropean sky demonstrators bring about the target resilience only if those centres that are jointly and collaboratively build-ing one virtual centre have all harmo-nised their operational procedures and systems through the operational excel-lence programme to allow the flexible delegation of airspace.

- A full ECAC-wide implementation of dy-namic cross-border sectorisation and advanced ATC automation can be done only once all ATSPs within the ECAC area have harmonised their operational

procedures through completion of the operational excellence programme. The reason is that full flexibility on allocation of traffic to any ATSP requires not only technical interoperability across all ADSPs, but also harmonised operational procedures and principles of all ATSPs.

Measure 2 consists of two actions, the ECAC-wide cross-border free route and A-FUA and the digital communications infrastructure. On top of the interdependencies between Measure 1 and Measure 2, the following additional interdependencies exist.

- The digital communications backbone consists of both air-ground and ground-ground connectivity. This connectivity is needed to exchange digital information in support of collaborative management of airspace and remote provision of air traffic services. The operational excellence programme, which aims to identify and implement best-in-class operations, requires synchronisation with the implementation of the digital communications infrastructure, as many of the solutions to be harmonised as part of the operational excellence programme require enhanced data exchange through the improved air-ground datalink and the ground-ground digital backbone.

- The future technology for the air-ground datalink is essential in enabling the transition to advanced ATC automation with tighter integration of air and ground systems, beyond the current controller-pilot datalink communication capabilities.

- The creation of an ADSP instance to support multiple ATSPs can be done only if a highly reliable and secure ground-ground digital backbone exists between the ADSP and the various ATSPs using that service.

Measure 3 is about delivering SESAR R&D solutions, closing the V4 gap and accelerating SESAR market uptake. It consists of delivering SESAR 2020 Solutions, ongoing AAS R&D beyond SESAR 2020, strengthening connection between R&D, standards and regulatory work, and using early demonstrators to accelerate the V4 phase. On top of interdependencies already mentioned, the following interdependencies exist.

- Some AAS-related solutions under research and development in SESAR 2020 will reach only V2. Further validation is required to fully validate these solutions. This will require some AAS solutions to be further validated beyond S2020.

- Using early demonstrators to accelerate the V4 phase can be done only after the R&D that is relevant to the AAS has delivered solutions that have reached V3 maturity, and their corresponding solution packs are publicly available. A distinction in timing for launching demonstration projects has to be made, between demonstration solutions that have reached V3 maturity in S2020 and those that will reach V3 maturity beyond S2020. Such demonstrations will be a useful vehicle to secure the specific inter-ADSP interoperability standard for synchronising trajectory information and an interface standard between ADSPs and ATSPs, allowing ATSPs to interact with the trajectories. As indicated in Figure 11, inputs will be required on the interface standard(s) between ADSPs and military stakeholders.

- Standardisation activities on specific solutions cannot start before the R&D that is relevant to the AAS has delivered those solutions at a minimum of V2 maturity, with the V2 solution packs publicly available. A distinction in timing for standardisation has to be made, between standardising solutions from S2020 and those delivered beyond S2020.

- The continued automation and artificial intelligence (AI) workstream on R&D beyond S2020 will deliver future solutions contributing to advanced ATC automation.

- The standardisation process will require adjustments to enable acceleration of the V4 phase. A strengthening of the connection between standardisation activities on the one hand and R&D, demonstration activities and industrialisation on the other hand is needed.

- A network around pioneer implementation projects needs to be created in such a way that it ensures an effective contribution to the acceleration of (European) standardisation and regulation.

- It is only after the standards and regulations have become available that a full and ECAC-wide roll-out of ADSPs will lead to ECAC-wide interoperability, irrespective of the brand of the industrial platform that serves the ADSPs and the ATSPs.

Once the ADSP instances have been created, the last remaining actions will become much easier, in particular because the number of ADSPs will be less than the number of FDP systems that need to be upgraded when the last remaining actions are applied to the current fragmented systems landscape.

- Tailored dynamic cross-border sectorisation will have begun long before an ECAC-wide ADSP implementation has been completed. However, once ADSPs running on the same standards and harmonised procedures have been created everywhere in the ECAC area, dynamic cross-border sectorisation will gradually be more flexibly applied, as it will become easier to connect across between any two pairs of ATSPs.

- Thanks to the substantial reduction in the number of instances of FDP systems (now corresponding to the number of ADSPs, not to the number of ATSPs), the introduction of advanced ATC automation will be substantially more cost-effective than the fragmented situation we have today.

- With fully interoperable ADSPs, and harmonised ATSPs all based on operational excellence, in place, the last step is the introduction of capacity-on-demand, by flexibly allocating ATSPs (or controllers) to where they are required by traffic demand, irrespective of the controller's physical location in Europe.

The proposed lines of actions and decisions depicted in the three measures depend on a number of prerequisites related to the regulatory framework and service provision aspects, which need to be addressed and enabled before the operational or technical developments can take place. Capacity-on- demand should be implemented across Europe by 2030. These interdependencies should therefore be addressed and sorted out by 2025, to allow early movers to initiate this development and support network-wide implementation by 2030.

- Although the vertically integrated model could continue operating, this is not the recommended option. The acquisition by ATSPs of ATM data from one or more data service providers could be developed in accordance with various options and business models. Commission services should enable this by confirming that the existing regulatory framework is appropriate or completing the necessary regulatory developments. According to Figure 27 of the AAS, these interdependencies should be addressed and sorted out by 2025.

- The creation of ADSPs to serve any ATSP within Europe is expected to require certification of the ADSP. To what extent this is really needed is currently being researched under the aegis of the Commission services.

- An appropriate cost and pricing mechanism may need to be defined to be harmoniously integrated within the existing charging scheme, avoiding double charging of the same costs.

- The creation of ADSPs to serve any ATSP within Europe may potentially require an update of the performance regulation in support of capacity assurance. The idea is that ANSPs should provide capacity in accordance with an agreed European plan, and their cost efficiency should consider the fixed costs linked to the capacity they offer, regardless of whether it is used or not. To what extent this is really needed is currently being researched under the aegis of the Commission services.

- The introduction of capacity-on-demand, by flexibly allocating ATSPs (or controllers) to where they are required, may potentially require an update of the performance regulation in support of geographically independent service provision. The current calculation of unit costs is country based, which is not compatible with the notion of capacity on demand. To what extent this is really needed is currently being researched under the aegis of the Commission services.

- The introduction of capacity-on-demand, by flexibly allocating ATSPs (or controllers) to where they are required, may require further changes in air traffic

control officer (ATCO) licensing. To what extent this is really needed is currently being researched under the aegis of the Commission services.

- Appropriate decisions affecting actions beyond the current SESAR 2020 programme should be taken on the implementation of Measure 3 with particular attention to governance and funding arrangements.

- An incentive scheme for early movers is needed to initiate pioneer implementation of AAS-related solutions, particularly those that relate to splitting ADSPs from ATSPs. The resulting network not only provides a critical mass, but also supports ongoing R&D and standardisation activities by providing feedback.

Appendix B: **Risk management**

Implementing the recommendations of the AAS requires a concerted effort from all stakeholders. This approach will need to focus on building and maintaining consensus for the transition, including adequate change management and risk management processes and buy-in from all stakeholder groups including professional staff.

In relation to the three top risks identified in the AAS, this transition plan addresses the following two top risks, which have direct operational and technical implications:

- lack of commitment and/or buy-in, resulting in delays or inefficient implementation;

- slow technology uptake, hampering the defragmentation of the European skies by virtualisation.

Although the delivery of this transition plan is already mitigating the risk related to lack of commitment to implementation, some initial considerations regarding the abovementioned top risks have been identified in relation to the execution of this transition plan. They are presented in Table 4.

Table 4: Risks, impacts and mitigation

Risk description	Impact/consequence	Mitigation actions
The inability of AAS transition plan changes to fit into the extant framework and governance may endanger the implementation of the short-term measures presented in the AAS	Within the short term implementation measures (Measures 1 and 2), changes planned will have to fit with already scheduled activities, including performance plans for RP3 and key programming documents, in particular from Network Manager, SDM, EASA and EASCG	• The AAS Transition Plan includes an analysis of its impact on the main programming documents from EASA (European plan for aviation Safety), Network Manager (Network Sstrategy Plan, NOP, NDOP, ERNIP, AOP, NM '7 Measures for 2019', the measures agreed as part of the NOP and that should be part of the RP3 response, etc.) and SESAR Deployment Manager (Deployment Programme). These entities will ensure alignment of their key programming documents with the AAS Transition Plan. • The AAS-Transition Plan short-term measures aim to facilitate completion of the capacity targets contained in RP3 performance plans. They are based on implementations that are already in the pipeline and thus should not negatively affect the preparation of the performance plans (at either national or FAB level) In any case, if needed, Member States may ask for some adaptations to their adopted RP3 performance plans, or at least adjust their cost base as authorised by Article 28(3)(a) of the Performance and Charging Regulation

Unsynchronised work on identifying the changes required for the regulatory and institutional framework may delay the implementation of the AAS Transition Plan	The AAS Transition Plan focuses on operational and technical aspects combining technology coming from the SESAR programme and changes related to airspace organisation. Meanwhile, the effective implementation of these proposed measures may require changes in regulatory framework, which must be clearly identified and implemented on time	• Ensure parallel and coordinated work on the identification of regulatory and institutional needs for successful AAS implementation • Take necessary measures to secure the timely delivery of the appropriate framework in support of the AAS transition plan
The successful implementation of the AAS Transition Plan milestones is not achieved because the general framework (institutional, regulatory, change management, programme management, incentivisation, etc.) is not robust and/or standardisation and regulatory bodies do not deliver materials (CS, RMTs) on time	• The institutional framework in which these activities will be fulfilled must be clear. Given this, boundaries and accountabilities should be defined and applied • The AAS transition plan provides a realistic roll-out plan. In this context, all the stakeholders and institutions involved will have to be held accountable for the delays they may cause (including knock-on delays) to the full implementation of the AAS transition plan • A suitable project management process, to be operated by, for example, a project manager, will have to be agreed, decided on and implemented to secure timely delivery of the elements of this Transition Plan	• With the support of the European and national political levels, properly consider the human dimension to ensure the full buy-in of the social partners and the full commitment of staff involved • ANSPs, airspace users, airports and manufacturers acknowledge their roles, ensuring their full commitment to the content agreed upon within the transition plan • Agree and decide a proper management process, including, for example, the designation of a project manager • Implement appropriate oversight mechanisms to monitor the activities undertaken by all stakeholders, but also to properly address if amendments to the timing or tasks are needed in order to fully deliver the expected results • Set up an efficient and thorough stakeholder consultation mechanism to ensure coordination among all stakeholders • Consolidate V4 gap assessment
Delays in implementing mature solutions as part of Measure 2 may have a negative impact on the overall AAS implementation planning	The timely provision of capacity as required over the coming years would be at risk, leading to increasing delays	Strictly monitor the implementation of these Solutions
Delays in delivering key SESAR 2020 Solutions may endanger the timely implementation of the AAS measures	If Solutions supporting increase of capacity are not ready on time, they will increase delays, especially if the expected traffic growth is realised. The AAS proposes solutions that must be implemented in accordance with the plan to get full benefits	Secure timely delivery of Solutions related to AAS by securing adequate resources, such as IOP, and provide close monitoring
There is no or insufficient Member State support for the proposed AAS implementation, endangering the timelines and coordinated implementation	This risks the operational goals of the AAS not being achieved	• Consult Member States' ministries of transport early and at a high level • Consult NSAs early • Consult Member States through the Single Sky Committee, EASA Committee and Eurocontrol Provisional Council, within their respective responsibilities
New Solutions are not used in practice	This could delay the return on early investments and the increase in operational performance	Design operational processes at an early stage along with industrial Solutions

Appendix C: **Master Plan Level 3 update**

C.1 Introduction

The executive view of the proposed Master Plan 2019 already reflects the conclusions and recommendations of the AAS. This integration work is the reason why the Master Plan was transmitted to the SESAR JU Board for adoption at a later date than initially foreseen, in April 2019. It is now important that the same work be carried out at the Master Plan's implementation view level. Accordingly, the Master Plan Level 3 implementation plan for 2019 has been updated to secure full alignment with the AAS and, in particular:

- to identify and highlight the technological Solutions that will be mature or approaching maturity for implementation by 2025;

- associate them with an implementation objective when they are mature or an outline description when they are only approaching maturity.

The specific changes made to the draft ATM Master Plan Level 3 implementation plan for 2019 to reflect the AAS transition strategy are provided in this appendix. Compared with the draft Level 3 implementation plan, which had already been reviewed by stakeholders, no additional implementation commitments are defined at this stage. Many elements of the AAS that relate to mature solutions are already covered by existing implementation objectives, while, for a small number of Solutions that are approaching V3 maturity, at this stage only outline descriptions have been introduced. These would need to be converted into proper implementation objectives in the next update cycle of the Level 3 implementation plan, using the agreed governance processes.

C.2 Summary of update proposal

The translation of the relevant part of the AAS transition strategy into the Master Plan Level 3 has led to the following changes from the previous draft Level 3 plan.

C.2.1 Executive summary

- Rewriting of the part 'The Airspace Architecture Study Transition Plan'.

- Addition of two new major ATM changes: ATM systems and virtualisation (this should solve some issues of inconsistency encountered with the previous edition).

- Addition of references to AAS transition plan milestone elements in the tables of the executive summary.

C.2.2 Strategic view

- Partial rewriting and repositioning of the section 'Airspace Architecture Study (AAS) Transition Plan' in the Master Plan Level 3 (now at the beginning of the strategic view chapter).

- Addition/editing of tables showing the milestones addressed by the AAS Transition Plan, and milestone elements with associated implementation objectives, SESAR Solutions or SESAR projects, where applicable (per Phases: 2020-2025; 2025-2030; 2030-2035).

- Modification of the tables about the four key features mapped to the major ATM changes, by adding SESAR 2020 Wave 1 period and references to milestone elements.

- Addition of two ATM major changes (ATM systems (in key feature AAS) and virtualisation (in key feature 'enabling aviation infrastructure') and modification of the others to reflect these additions.

- For each strategic view, addition of a specific section linking to AAS Transition Plan, and of a specific roadmap (table) showing objective, link to SESAR Solution, link to milestone element, planned full operational capacity (FOC) date, current progress (as a percentage, from the Master Plan Level 3 report) and expected achievement date based on individual ANSPs'/states' declarations.

C.2.3   Deployment view

- For each key feature, amendment of the summary table to include reference to milestone elements addressed by the individual implementation objectives.

- In the deployment view description of each implementation objective, addition of reference to the AAS milestone element addressed (if relevant).

C.2.4   New outline description chapter

Including five outline descriptions for the period 2020-2025, covering the gaps identified so far and requiring an implementation objective.

C.2.5   Annexes

- Modification of Annex 3 ('Relevant mappings of the Level 3 Plan 2019') to add links to milestone elements.

- Addition of Annex 5, 'MPL3 Plan Roadmap with reference to AAS TP'. This is the aggregated view of all the individual blocks shown in each strategic view.

C.3   Coverage of AAS transition milestones in Master Plan Level 3

Table 5 captures the extent to which the AAS milestones are covered by the implementation planning in the (latest draft) Master Plan Level 3. The assessment of the milestone's achievement by indicated AAS phase was done in coordination with the SESAR Deployment Manager assessing the current status of corresponding Master Plan Level 3 implementation objectives and SESAR Deployment Programme families.

Table 5: Master Plan Level 3 coverage of AAS-related solutions

AAS-TP Phase		AAS Milestone	SESAR Solution	MPL3 Objective	Stakeholder						SDP Family
					ANSP	APO	USE	ECTL NM	MIL	NSA/REG	
2025	AM-1.1	Air-ground data exchange - CPDLC	Nil	ITY-AGDL	■		■	■	■		6.1.1, 6.1.4, 6.1.5
2025	AM-1.2	Air-ground data exchange	#115	OD-1							6.1.2
2025	AM-1.3	G/G connectivity (OLDI including the exchanges for extended AMAN)	#05	ATC17	■		■	■			3.2.1 (TBC)
2025	AM-1.3	G/G connectivity	#05	COM11.1	■		■	■			No mention
2025	AM-1.3	G/G connectivity	#05	ITY-FMTP	■		■	■	■		No mention
2025	AM-1.3	G/G connectivity (OLDI including the exchanges for extended AMAN)	#05	ATC15.2	■		■	■			Family 1.1.2
2025	AM-1.4	eFPL based on ICAO FF-ICE supporting SBT transition to RBT	PJ.18-02c	FCM08	■		■	■			4.2.3
2025	AM-1.5	G/G connectivity - SWIM Yellow	#46	INF08.1	■		■	■			Families AF5
2025	AM-1.6	FRA cross-border above FL310	#66	AOM21.2	■		■				3.2.4
2025	AM-1.7	FRA cross-border below FL310	#66, #33 PJ.06-01	OD-2							No mention
2025	AM-1.8	Advanced FUA and ASM Tools, Real time airspace data, Full Rolling ASM/AFTCM	#31	AOM19.1	■		■				3.1.1
2025	AM-1.8	Advanced FUA and ASM Tools, Real time airspace data, Full Rolling ASM/AFTCM	#31	AOM19.2	■		■				3.1.2
2025	AM-1.8	Advanced FUA and ASM Tools, Real time airspace data, Full Rolling ASM/AFTCM	#31	AOM19.3	■		■				3.1.3
2025	AM-1.9	Implement Target Times (SAM, API)	#18	FCM07	■		■	■			4.3.1, 4.3.2
2025	AM-1.10	Automated support for dynamic sectorisation	#66	AOM21.2			■				3.2.1
2025	AM-1.11	Occupancy counts and Traffic monitoring volumes exchanges (STAM)	#17	FCM04.2	■		■	■			4.1.2
2025	AM-1.12	Network related data exchanges with operational stakeholders (AOP/NOP interfaces, Aeronautical data, flight plan data, network data)	#20	FCM05	■		■	■			4.2.2, 4.2.4
2025	AM-1.13	Data exchange to support traffic complexity	#19	FCM06	■		■	■			4.4.2
2025	AM-1.14	Collaborative Flight Planning (CPR, FSA, AFP)	Nil	FCM03	■			■			4.2.3

Key:

■ (green)	On track, will be deployed by the planned date
■ (light blue)	On track, but requires careful monitoring (plans need to be consolidated)
■ (blue)	Ar risk of not being deployed by the dates necessary
☐ (white)	Not assessed, implementation reports not available yet

AAS-TP Phase		AAS Milestone	SESAR Solution	MPL3 Objective	Stakeholder						SDP Family
					ANSP	APO	USE	ECTL NM	MIL	NSA/REG	
2025	AM-1.15	Enhanced tactical conflict detection & resolution (CD&R) services and conformance monitoring tools for en-route	#27, #104	ATC12.1	▨						3.2.1
2025	AM-1.16	Air traffic services (ATS) datalink using iris precursor	#109	OD-3							
2025	AM-1.17	Cooperative surveillance ADS-B/WAM	#114	OD-4							
2030	AM-4.1	Dynamic airspace configurations (DAC) - Prerequisites	#44W2	-							
2030	AM-4.2	DAC - flexible sectorisation boundaries dynamically modified based on demand	#44W2	-							
2030	AM-4.3	Collaborative control and multi sector planner (MSP) in en-route	#63 #70W2	ATC18							
2030	AM-4.4	Delegation of airspace amongst ATSUs based on traffic/organisation needs (either static, dynamic or on contingency)	#93W2	-							
2030	AM-4.5	Work station, service interface definition & virtual centre concept	PJ.16-03	OD-5							
2030	AM-5.1	Higher levels of automation in ATC to support full TBO	-	ATC12.1	▨						3.2.1 (TBC)
2030	AM-5.1	Higher levels of automation in ATC to support full TBO	-	ATC18	▨						
2030	AM-5.1	Higher levels of automation in ATC to support full TBO	-	AOM21.2	▨		▨	▨			3.2.1 (TBC)
2030	AM-5.2	Enhanced network traffic prediction and shared complexity representation	#45W2	-							
2030	AM-5.3	Next generation AMAN for 4D environment	#01W2	-							
2030	AM-5.4	Digital integrated network management and ATC planning (INAP)	#48W2	-							
2030	AM-5.5	Improved ground trajectory predictions enabling future automation tools	#53W2	-							
2030	AM-5.6	RBT revision supported by datalink and increased automation	#57W2	-							
2030	AM-5.7	HMI interaction modes for ATC centre	#96W2	-							
2030	AM-5.8	Improved vertical profiles through enhanced vertical clearances	#56W2	-							
2030	AM-5.9	Higher levels of automation supporting sectorless ATCO work	-	-							
2035	AM-8.1	Flight-centric ATC and improved distribution of separation responsibility in ATC	#73W2	-							
2035	AM-9.1	Flight object interoperability and SWIM Blue profile	#28, #46 PJ.18-02b	INF08.2	▨			▨			5.6.1, 5.6.2
2035	AM-9.2	Dynamic E-TMA for advanced CDO/CCO and improved arrival and departure operations	#08W2	-							
2035	AM-9.3	Enhanced integration of AU trajectory definition and network management processes	#38W2	-							
2035	AM-9.4	Trajectory prediction service	#88W2	-							
2035	AM-9.5	Mission trajectories management with interrated dynamic mobile areas type 1 and type 2	#40W2	-							
2035	AM-9.6	RBT revision supported by datalink and increased automation	#57W2	-							
2035	AM-10.1	De-couple ATS provision, ATM services, integration services and geographically fixed services	-	-							

Appendix D: **Analysis of other supporting plans**

D.1 Introduction

The conclusions and recommendations of the AAS suggest a phased but substantial development of the European airspace architecture and a digital transformation of air navigation service provision. This triggers a rethinking of the way services are provided, with a view to delivering the capacity needed by airspace users and building a state-of-the-art, scalable and resilient system that will remain at least as safe as today.

To achieve this, it is necessary that all components of the aviation community work in the same direction and at the same pace. This is why it has been deemed necessary to analyse the key documents surrounding the European ATM Master Plan and supporting its implementation, and to identify where amendments or refocusing would appear to be desirable.

The following have been analysed and recommendations are provided on how to ensure best alignment with the direction proposed in the AAS:

- Network Manager's Network Strategy Plan (NSP)
- EASA's European Plan for Aviation Safety (EPAS)
- EASCG's RDP
- SESAR Deployment Manager's deployment programme (DP).

This is detailed in this appendix.

The life cycle of improvements to ATM (e.g. through SESAR Solutions), from initial idea to operational use, is organised through a number of different plans, each with their own scope, governance, level of commitment and reporting mechanisms. The life cycle model itself, as used for the past two decades, can be found in the E-OCVM. Figure 12 provides an overview of most relevant plans that have been analysed in preparing this AAS Transition Plan.
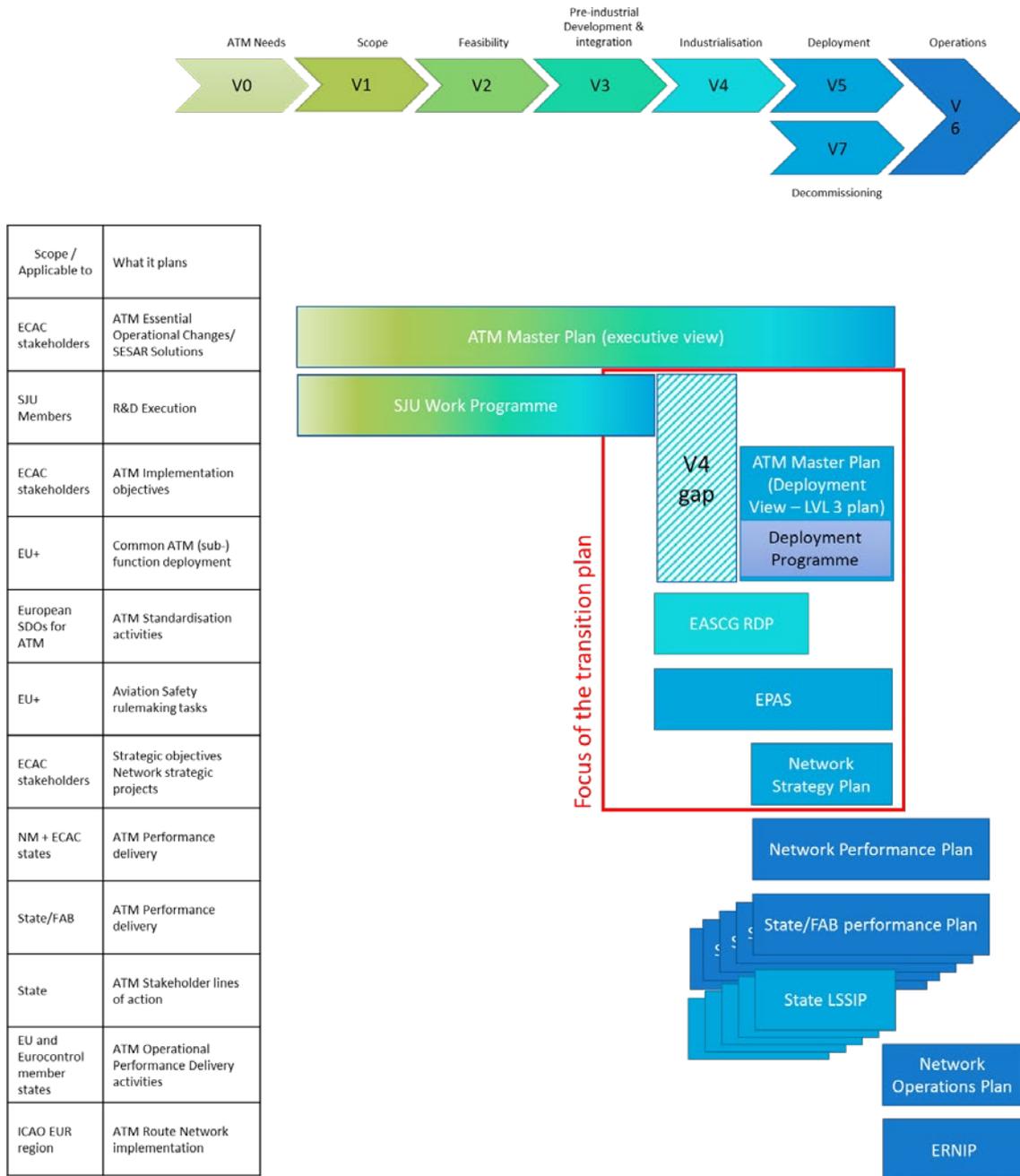
Figure 12: Overview of relevant plans, including V4 gap location

D.2 Network Strategy Plan 2020-2029

The Network Strategy Plan covers the period 2020-2029 but focuses on the RP3 period 2020-2025. It covers a short-/medium-term step and a long-term step. The plan must remain consistent with the Network Functions Implementing Regulation in both format and scope.

The short-term step will ensure network optimisation in the areas required for the execution of the network functions and tasks, enabled by the joint implementation with all operational stakeholders of major airspace reconfiguration and operational excellence projects, aligned to the

outcome of the AAS; and a better integration of airports and terminal airspace systems into the network, supported by a new NM system based on innovative digital technologies and on ground-ground and air-ground connectivity.

This aims primarily at achieving a common network view, optimising operational performance at network level and making the best use of the available — but scarce — human resources, by the following means.

- Set up an optimum airspace structure that responds network wide to SES performance targets and adapts capacity to demand.

- Optimise sectorisation and airspace structures, in particular at cross-border level.

- Optimise connectivity to terminal airspace systems.

- Improve the flexibility of service provision by addressing the operational utilisation of resources.

- Improve the capacity planning of week-nights and weekends.

- Implement operational excellence initiatives together with the ANSPs and airports to further foster operational and technical harmonisation and interoperability. This new initiative would aim to identify best practices and capture quick wins (through changes in operational procedures, operational utilisation of resources, smaller adaptations to systems, etc.) among all stakeholders and effectively support their implementation to reduce delays.

- Establish capacity commitment between NM and ANSPs through the NOP, consolidating DCB optimisation to address both lack and surplus of capacities considering network and local conditions.

- Improve vertical flight efficiency to reduce gas emissions and fuel consumption.

- Optimise flight planning, airport operations and flow management through the integration of data and constraints. This includes:

▶ sharing the main enablers that ensure a common network view (e.g. capacities, trajectories, configurations, activations);

▶ improving traffic predictability and the assessment of traffic complexity;

▶ consolidating an efficient set of ATFM solutions based on improved traffic predictability and network impact assessment.

- Undertake a vast modernisation of the Network Manager's system to support all new emerging operational concepts, based on the implementation of its Future System Architecture study.

Specific attention will be paid to the performance of — and access to — the most congested airports/TMAs, a sensitive component of the network. This will involve:

- improving the efficient use of airport infrastructures through advanced collaborative operations;

- integration of airport and network operations, addressing the links between AOP and NOP and the connectivity between airport operations centre and Network Manager operations centre;

- advanced airport capacity planning with end-to-end optimisation at network level.

In parallel, all actors will implement the Common Projects components of SESAR. From a network strategy perspective, the Network Manager will ensure full coordination of AF3 and AF4 families where most network benefits are expected and where synchronisation will have to be carefully managed.

The first actions required for the network functions to support the new ambitions stemming from the aviation strategy for Europe will be initiated while responding to the requirements of the NF IR. Additional dimensions of network performance will be analysed, in terms of connectivity, passenger service, and pace of implementation of environmentally friendly technologies and procedures. The Network Manager will enlarge its operational intelligence capabilities to become an observatory in support of the political bodies concerned: collecting the

operational data, taking part in the analyses, identifying areas for improvement in coordination with all network actors, and facilitating the analysis and coordination of air transport with other modes of transport for crisis situations. A return from experience will be deduced from these initial actions to further refine, if necessary, the scope of the network functions to address those new aspects.

Another cornerstone of this transformation will be to address infrastructure developments in close cooperation with all parties concerned. It will, in particular:

- monitor the network's day-to-day operational and technical performances to the extent required for the execution of the network functions and tasks and the fair sharing of the scarce resources;

- develop, organise and provide common network support services related to the network functions that are required by operational stakeholders, as stipulated in the NF IR or as otherwise decided through the network CDM processes;

- ensure that infrastructure services will meet network performance objectives and address the aviation requirements and spectrum constraints as they evolve, e.g. to support future remotely piloted aircraft systems (RPAS) operations, and also any other new entrant operations such as balloons and high-altitude pseudosatellites.

Several additional functionalities for network operational performance with direct benefits for airspace users will be gradually implemented:

- the generalisation of the user-driven prioritisation process;

- the implementation of information sharing in support of the business and mission trajectories;

- digital integrated briefing;

- full implementation of EPP;

- progressive implementation of enhanced collaborative airports performance management;

- gate-to-gate optimisation with airside-landside integration.

This will require to be facilitated by extensive dialogue among operational stakeholders with regard to potential improvements in the regulatory framework as well as by the implementation of those more structural/institutional changes in the areas of:

- harmonised ATCO licensing;

- harmonised conditions of employment;

- refinement of the route-charging model;

- enhanced coordination between all actors to simplify and further integrate network functions and tasks from R&D, industrialisation and implementation into operations;

- optimised integration of civil and military activity and requirements.

D.3   Deployment Programme 2018

The DP 2018 provides a detailed view of the implementation of the PCP and represents a further breakdown and update of the requirements stemming from the Pilot Common Project Regulation and clearly defining the scope of the related implementation activities, as well as the suggested approach to be followed. It consists of 48 families detailing the scope, features and main attributes of the implementation activities in a consistent work breakdown structure. Most of the SDP 2018 families address the core PCP requirements, and some of them the PCP prerequisites as well as the additional implementation activities closely linked with PCP requirements. The SDP 2018 horizon is 2025, as the last FOC date for the 48 families is 1 January 2025, except the airborne equipage for family 6.1.2 (ATN B2-based services in ATSP domain), for which 2026 is the FOC date.

Starting from AAS recommendations and requirements associated with the 2025 horizon, the analysis performed consists of the identification of gaps from the corresponding elements of the PCP, which is at the origin of the SDP 2018.

Only those AAS elements linked with PCP requirements have been taken into consideration.

As the whole scope of AAS milestones concerning the 2025-2030 time horizon is not relevant to the SDP 2018's coverage, only an initial assessment of prerequisites associated with these milestones has been conducted.

The AAS proposes three high-level milestones within the 2025 time horizon:

- ECAC-wide implementation of cross-border free-route, air-ground and ground-ground connectivity;

- complete airspace reconfiguration supported by an operational excellence programme to capture quick wins;

- set-up of an enabling framework for ATM data service providers, capacity-on-demand service and rewards for early movers, first ADSP is certified.

The first two milestones are relevant to the SDP 2018 requirements, whereas the third milestone covers institutional and regulatory aspects and therefore is not part of the analysis.

The two relevant AAS milestones have been further broken down into their constitutive elements, which, in turn, have been mapped to the corresponding SDP 2018 families. The result is consolidated in Table 4.

Table 1: Overview of gaps and recommendations related to the programme

AAS milestone elements	SDP 2018 requirements	Gaps identified and recommendations
FRA above FL310	Fully covered by family 3.2.4	None
FRA cross-border	Covered by the PCP review proposal from SDM. As the timing for SDP 2019 is not sufficient to consider the PCP review, the coverage of FRA cross-border aspects should be considered for SDP 2020	Gap, FRA cross-border aspects to be addressed by SDP 2020, pending Commission decision on PCP review proposal
FRA to ensure connectivity with TMA	Covered by the PCP review proposal from SDM. As the timing for SDP 2019 is not sufficient, this should be considered for SDP 2020	Gap, FRA connectivity with TMA to be addressed by SDP 2020, pending Commission decision on PCP review proposal
System support for national, cross-border and lower-airspace FRA implementation	Fully covered by family 3.2.1. This family addresses the system and tools required for different FRA implementations (national, cross-border, connectivity with TMA)	None
A-FUA and ASM	All ASM and A-FUA requirements are well covered by families 3.1.1, 3.1.2 and 3.1.3. Family 3.1.4 (Management of dynamic airspace configurations) supports the AAS milestones beyond 2025	None
Ground-ground legacy exchanges	Basic OLDI and SYSCO are covered by family 3.2.1, and the legacy protocols are listed in family 5.2.2	None
Ground-ground data exchanges with NM	Mostly covered by family 4.2.3 (FSA, AFP, CPRs) and family 4.4.2 (EFD). The eFPL exchanges need to be included and to be reflected in the next SDP editions, in line with the PCP review proposal from SDM	Design operational processes at an early stage along with industrial Solutions
The NM exchanges with airports are part of family 4.2.4	Partial gap, eFPL based on ICAO FF-ICE to be addressed by SDP 2020, pending Commission decision on PCP review proposal	
Ground-ground connectivity SWIM Yellow Profile	Fully covered by families 5.3.1, 5.4.1, 5.5.1 and 5.6.1. Family 5.6.1 needs to be amended to reflect the exchange of eFPL. The operational content of network-related SWIM exchanges is covered by families 4.1.2, 4.2.1 and 4.3.1.	Partial gap, eFPL to be linked with family 5.6.1

Ground-ground connectivity SWIM Blue Profile	Covered by family 5.6.2, although it should be noted that the maturity of this family is very low, prerequisites are missing and validation activities are still needed to demonstrate readiness for implementation. The SWIM Blue Profile is the subject of a PCP review, and more detailed recommendations can be defined when the final draft of the PCP review is available	None for the time being
Air-ground datalink exchanges	The AGDL implementation including the multi-frequency datalink network is fully covered by families 6.1.1 and 6.1.3. The airborne elements are covered by family 6.1.4	None
Air-ground trajectory exchanges	The automatic dependent surveillance contract (ADS-C) and EPP are fully covered by family 6.1.2	None
Airspace reconfiguration supported	The technical enablers to support airspace reconfiguration are covered by families 3.1.4 and 3.2.1. However, the airspace reconfiguration mainly addresses the airspace design issues, covering the identification of network efficiencies and delivery of optimised airspace structures based on free-route traffic flows. These activities fall within the scope of NM, so they do not need to be reflected in SDP 2018	None
Operational excellence programme	This is not covered by SDP 2018. Nevertheless, since this element is aimed at identifying best practices by way of procedural, staffing and system improvements and supporting implementation in order to reduce ATFCM delays without direct links with any requirements stemming from the PCP IR, it cannot be reflected in any further edition of the SDP	None

The FOC timing for the SDP 2018 families related to AF3 and AF4 seems appropriate (end of 2021), although the upcoming PCP revision might impose a different timing for FRA cross-border aspects. The timing for SDP 2018 related to AF5 and AF6 is a bit tight (end of 2025), but the validation activities for some elements of these families are ongoing and bringing the FOC closer may not be appropriate. However, all elements for SWIM Yellow Profile related to aeronautical and network exchanges are in place; therefore, the operational stakeholders might consider implementing these elements before the FOC dates.

The AAS proposes four high-level milestones for the 2025-2030 time horizon:

- virtual centres and dynamic airspace configuration implemented at large scale
- gradual transition towards higher levels of automation
- capacity-on-demand arrangements implemented across Europe
- new ATM data service provision model implemented across Europe.

The prerequisite for the first two milestones are assessed against the SDP 2018 requirements, whereas the remaining two milestones cover mostly institutional and regulatory aspects and therefore have not been considered for the analysis.

The dynamic airspace configuration (DAC) is fully covered by the SDP 2018 (family 3.1.4). As some DAC validation activities are still ongoing, the content of SDP 2018 family 3.1.4 might need to be revisited and adapted depending on the outcome of these validations, although the core DAC part is already covered. In the terms of DAC prerequisites, the SDP 2018 provides sufficient coverage.

The prerequisites for virtual centres in terms of data interoperability and ground-ground data exchanges are also well embedded in different families of the SDP 2018, as elaborated above. The SWIM Blue Profile functionalities might not be essential, as they could potentially be supplied by the legacy exchanges. The remaining parts of virtual centres — infrastructure layers, technical components, operational procedures and organisational arrangements — are outside the PCP's scope and therefore also outside the scope of the Deployment Programme.

The AAS listed the set of automation and productivity tools together with the corresponding solution projects that could support the achievement of high-level milestones for gradual transition towards higher level of automation. In the first SESAR research and innovation programme (SESAR 1 2008-2016) validated the majority of automation solutions (although most of them had been industrialised before SESAR) and they are thus part of the PCP IR. The PCP-related automation tools (Monitoring conformance service (MONA), medium-term conflict detection (MTCD), conflict resolution assistant (CORA), conflict detection tools (CDT) and system support for extended AMAN) could be considered prerequisites to achieve the second AAS milestone, 2025-2030, and they are well reflected by different SDP 2018 elements (family 3.2.1, family 1.1.2, families belonging to AF4). The ATC automation solutions that are in the validation pipeline offer only incremental improvement of existing automation tools; changes that are more radical might be needed. Additional R&D activities might also be needed to explore the next level of ATC automation.

RECOMMENDATIONS

In order to ensure the AAS's alignment with future deployment programme editions, it might be appropriate for the DP to address the following items:

- FRA cross-border aspects
- FRA connectivity with TMAs
- eFPL based on ICAO FF-ICE.

These requirements are included in the revision of the PCP IR proposed by the SDM to the Commission and will be reflected in the corresponding editions of the Deployment Programme, after Commission review and approval.

n addition, the following considerations need to be highlighted. Some are already addressed by the Deployment Programme Planning View 2019 edition:

- in order to pave the way for the high-level AAS milestones in 2025-2030, the operational stakeholders might consider speeding up the implementation of SWIM Yellow Profile aeronautical and network-related data exchanges;

- to allow a timely start for the gradual implementation of higher ATC automation levels, the operational stakeholders should also consider accelerating the implementation of system support for extended AMAN ahead of the 2024 FOC date;

- more focused R&D activities related to automation tools should be considered in order to ensure the advent of the next generation of automation tools.

D.4 Draft European Plan for Aviation Safety (EPAS) 2020-2024

The European Plan for Aviation Safety (EPAS) provides a proactive approach to supporting the future growth of aviation while securing a high and uniform level of safety and environmental protection. EPAS is to evolve towards a more integrated approach, supporting the management of different types of risks (safety, security, capacity and environment) and supporting innovation across the total aviation system. As the plan is updated on a yearly basis, the current tasks described in paragraph 15.3 of the draft EPAS 2020-2024 will be continually reviewed and updated, including the in-troduction of new tasks, when appropriate and in accordance with the existing processes. The analysis of the draft EPAS 2020-2024 covered in this section has focused on elements in the AAS that could imply either the use or updates to existing tasks. The analysis is based on the AAS; however, further details, including quantified impact assessment by the SESAR JU, will be needed for a more precise evaluation of the plan. In Table 5, the left-hand column captures elements of the AAS report that may relate to existing EPAS elements in the middle column and the remarks in the right-hand column.

Table 2: Analysis of possible impact on EPAS (draft 2020-2024)

AAS element	Corresponding EPAS task	Remarks
Air traffic controllers		
Changes in current ATCO practices from sector-oriented to flight-/flow-oriented operations as well as demand-based cross-border dynamic sector operations	Reference mission trajectory -RMT.0668 Regular update of ATCO licensing rules (IRs/AMC/GM)	It is considered that the current regulatory package is sufficient for the implementation of the AAS element. Possible need for implementation support by providing some additional GM. If the elements are significant, new terms of reference will be needed and a new task will be initiated accordingly
	RMT.0719 Regular update of ATM/air navigation service (ANS) CRs (with regard to PART-ATS)	RMT.0719 could be used to address the aspects relevant to the technical requirements for flight-/flow-oriented operations. However, if significant, separate task may need to be initiated
Cybersecurity		
Need to ensure strong protection of data against cybersecurity treats. A number of guiding principles should be defined for the organisational and technical measures that are needed to encourage cyberresilience. Cybersecurity practices in ATM will need to be adapted to comply with the relevant European regulatory framework, which is not always aviation specific: General Data Protection Regulation, NIS Directive and EC 373/2017	RMT.0720 Management of information security risks SPT.071 Strategy for cybersecurity in aviation	The work of RMT.0720 is expected to deliver an EASA opinion in Q3 2020. Adoption of the relevant implementing regulation is possible in 2021. The future developments should comply with the relevant implementing regulation. Covered in the current draft EPAS
Common requirements for providers of ATM/ANS services and other ATM network functions and their oversight, Regulation (EU) 2017/373		
Specific requirements for certification and oversight of ATM data providers	RMT.0719 Regular update of ATM/ANS rules (IRs/AMC&GM)	Currently the terms of reference of RMT.0719 include provisions to start working on the ADSP concept (introduction, development of new concepts/technologies)
Interoperability		
Datalink services, including: • EPP availability on ground # 115 • conformity with interoperability requirements	RMT.0524 Datalink services RMT.0161 Conformity assessment	For the time being, RMT.0161 is being initiated
SESAR 2020 Wave 1 • Flight object interoperability PJ.18-02b • eFPL supporting SBT transition to RBT PJ.18-12c • Work station, service interface definition and virtual centre concept PJ.16-03	RMT.0682 Implementation of the regulatory needs of the SESAR projects DA/AMC/GM	The task is laid down in the draft EPAS. Assessment of the regulatory action is necessary on a case-by-case basis for each solution when mature

SESAR 2020 Wave 2	RMT.0682 Implementation of the regulatory needs of the SESAR projects	The need for additional RMTs besides RMT.0682 is to be assessed at a later stage when the solutions and concepts are mature
• Dynamic E-TMA for advanced continuous climb and descent operations and improved arrival and departure operations CS # 8	DA/AMC/GM	
• Enhanced integration of airspace user trajectory definition and network management processes CS #38		
• DAC CS #44		
• Collaborative control and multi-sector planner (MSP) in en route CS #70		
• Extended AMAN horizon CS #5		
• Transition from calculated take-off time (CTOT) to CTOT and target time arrival (TTA) CS #18		
• Enhanced network traffic prediction and shared complexity representation CS #45		
• Next-generation AMAN for 4D environment CS #1		
• Digital integrated network management and ATC planning (INAP) CS #48		
• Improved ground trajectory predictions enabling future automation tools CS #53		
• RBT revision supported by datalink and increased automation CS #57		
• Human-machine interface (HMI) interaction modes for ATC centre CS #96		
• Improved vertical profiles through enhanced vertical clearances CS #56		
• Delegation of ATS provision among ATSUs CS #93		
• Flight-centric ATC and improved distribution of separation responsibility in ATC CS #73		
• SWIM Technical Infrastructure (TI) Green Profile for ground-ground civil-military information sharing CS #101		
• Trajectory prediction service CS #88		
• Mission trajectories management with integrated dynamic mobile areas type 1 and type 2 CS #40		
• Generic controller validations CS #73		
• FCI terrestrial datalink and A-PNT enabler (L-DACS) CS #60		
• Integrated CNS and spectrum CS #76		
• FCI services CS #77		

D.5 EASCG European Standardisation Rolling Development Plan (RDP)

A preliminary assessment has been made of the AAS report content in relation to existing and already planned standardisation material (e.g. standards, guidance and certification specifications). A number of existing standards were already explicitly referenced in the AAS report. The assessment considers the impact on the EASCG Rolling Development Plan (RDP) to identify any gaps.

An initial list of standards in support of the AAS target architecture, covering all three measures, is given in Table 3. It identifies subject areas described in the AAS report where standards would support the target architecture's implementation. Additional columns provide the state of play, a non-exhaustive list of associated standards within the scope of AAS, traceability to the Master Plan Level 3 and assessed impact on the RDP. The assessment proposes a new standard for Measure 3, currently entitled 'Specification on ATM data service definition and requirements', which encompasses the standards (inter-ADSP and ADSP-ATSP standards) illustrated in Figure 11. The drawing up of this standard will depend on the availability of various inputs (e.g. concept of operations on virtual centres, harmonised operational concepts, service-oriented architecture definition, business models, legal liabilities applicable to air traffic service and data service providers, charging scheme review for capacity-on-demand services), some of which will be delivered by the SESAR 2020 R&D activities, while others would be expected from the regulatory and business model analyses being performed by the Commission.

Numerous operational procedures and implementation approaches could be standardised but would be better documented in the form of best practices. Table 4 provides the results of the assessment in the same layout as the first. In particular, such guidance material will directly support the planned Operational Excellence Programme.

A summary for Measures 1 and 2 (short term) follows.

- eFPL standardisation is in its final stages and NM has already integrated its support. ICAO material is on track for publication by 2021, followed by an updated IFPS user's manual and the integration of military requirements (iOAT flight plan).

- The integration of downlinked EPP data into flight data processing systems of air traffic service providers and NM is considered a local matter in the existing ATM system configuration but will need standardisation when flight object interoperability and ATM data services are introduced. EASA is currently updating the A-CNS certification specification within RMG.0524.

- The needs for improved interoperability requirements and productivity tools are expected to be supplied through the full implementation of existing standards.

- ATM-specific cybersecurity standards need further inputs from R&D and implementation activities. It is expected that in general the application of common information technology security standards will suffice, complemented by those under development as documented by the ICAO SSGC, ECSCG and global best practices.

A summary for Measure 3 (medium/longer term) follows.

- A new standard on ATM data service definition and requirements is planned but depends on the availability of a series of input documents and potential regulatory actions. This corresponds to Figure 11, Measure 3, inter-ADSP and ADSP to ATSP standards.

- Development of the standardisation material associated with Measure 2 is continuing, notably extending the SWIM Yellow Profile to incorporate the Green Profile requirements.

LIMITS OF THE ANALYSIS AND NEXT STEPS

In the limited time available to develop this transition plan, only a preliminary analysis could be performed. It should serve as an input to a robust and comprehensive gap analysis that should be performed by the EASCG to provide:

- a list of all standards available today to support the quick implementation of the various measures related to the ASS Transition Plan;

- a list of standards still required to fill the gap from the full AAS Transition Plan.

The second list will be the basis for transform the needs into the different work programmes of the appropriate SDO and therefore result in an update of the RDP. It will also show clearly where the community needs to invest resources, expertise and effort to develop these required standards in order to close the V4 gap.

The EASCG will report back to the SESAR JU Master Plan Committee on these deliverables and will make them publicly available on its website (www.eascg.eu).

1.   Standards/Specifications

Table 3: Possible impact of AAS elements on standards material in the EASCG RDP

Subject matter identified from the AAS report (bold)	Status	Related material (non-exhaustive)	ATM MP Level 3 reference	EASCG RDP impact
eFPL (based on FF-ICE) Extended flight plan listed in the AAS report is superseded by eFPL (based on FF-ICE)	Standards being finalised	ICAO: Annexes 2 and 15 SARPS (ready 2021), Doc 9965 Vol 2 guidance (ready 2021), Doc 7030, FIXM (ready) ECTL: IFPS user's manual, IFPS specification	FCM08	No
Extended projected profile (EPP)	Standards available	ICAO: GOLD (Doc 10037) ECTL: SWIM specifications, MTCD/MONA/TP specifications (safety nets) Eurocae: ED-228A EASA: A-CNS certification specification (a draft of the update is available — RMG.0524)	OD-1, INF08.1, INF08.2, ATC12.1	No
Increased ATC interoperability Added new functionality to OLDI, in particular support for FRA, consistent view of flight at all times	Standards available	ICAO: AMHS (EUR Doc 20) ECTL: OLDI, NM B2B, SWIM (Yellow Profile integration of Green Profile) Eurocae: ED-133 (update)	ATC-17, COM10, INF08.1, INF08.2	SWIM TI Yellow Profile development (AAS Measure 3), potential update of other standards in RDP
Extension of A-FUA for dynamic airspace configuration	Standards available	ECTL: FUA specification, SWIM specifications, ASM specifications, ERNIP (actions relating to FUA)	OD-2, INF08.1, INF08.2, AOM19.1, AOM19.2, AOM19.3	Potential update of standards listed in RDP
Automation and productivity support Add or clarify functionality to existing standards. Airport automation and productivity are out of scope	Standards available	ICAO: GOLD (Doc 10037) ECTL: MTCD, MONA, TP specifications (safety nets), OLDI specification, SWIM, NM B2B, IFPS user's manual	ITY-AGDL, ATC12.1, ATC17 AOP05, AOP04.1, AOP04.2, AOP12, AOP13, AOP16, AOP18	Potential update of standards listed in RDP

New standard on ATM data service definition and requirements A framework standard defines functional and interoperability requirements applicable to services entities/providers (see AAS Report Figure 18, Table 5). Includes quality of service parameters, performance, interfaces, harmonised service level agreements and virtualisation. The standard will support EASA regulatory action for ADSPs, certification, procurement and performance monitoring	New, proposed standard for Measure 3	ICAO: GOLD (Doc 10037), AMHS (Eur Doc 20), PBN manual (Doc 9613) ECTL: SWIM specifications, ADQ specifications, TP specification, AMHS specification, FMTP specification, PENS, datalink, PBN handbooks EASA: A-CNS certification specification, Part-AIS Industry: open standards Eurocae: ED-133 (to be updated)	COM10, NAV03.1, NAV03.2, NAV10, NAV12, INF08.1, INF08.2, ITY-FMTP, COM12, ITY-AGDL	New, proposed new entry for RDP (AAS Measure 3)
Cybersecurity procedures, measures and training Covers both air-ground and ground-ground information exchanges. Standards derived from application of GDPR, NIS Directive, Regulation (EU) 2017/373	Standards available	ICAO: Annex 17 CEN: EN16495 ISO/IEC: 27000 series ETSI: TSs/TRs Industry standards		No (see ECSCG RDP)
Cross-border ATS provision, licensing, capacity-on-demand service, contingency and training	Standards available	EASA: ATCO easy guide (consolidates IR/AMC/GM), easy access rules for ATM-ANS Annex XIII (ATSEP) ECTL: ATSEP CCC training specification (for parts not covered by EASA easy access rules) ICAO: Documents 10056 and 10057		No

NB: Potential update of standards: it is assumed that any further need for harmonisation can be achieved by fully implementing existing material. Minor updates to standards may be required by the programmes.

2.   Guidelines

Although (updated) standards are essential for some ATM developments, many other aspects can equally well be supported by provision of guidelines. Even if guidelines are not covered as such by the EASCG rolling development plan, Table 7 nevertheless provides a list of AAS topics for which the development of (updated) guidelines should be considered.

Table 4: Possible needs for (updated) guidelines related to AAS elements

Subject matter identified from the AAS report	Status	Related material (non-exhaustive)	ATM MP Level 3 reference	EASCG RDP impact
Guidelines for military operators relating to eFPL implementation (eFPL iOAT flight plan)	New (in progress)	ECTL: IFPS user's manual	FCM08	N/A
Guidelines on demand-based cross-border dynamic sectorisation and sector operations	New		OD-2	N/A
Guidelines on cross border contingency arrangements for data service providers	New or potential update of guidelines	ECTL: amendment to guidelines for contingency planning of ANS		N/A
Guidelines in support of automation and productivity support	Potential update of guidelines	ECTL: amendment to guidelines on MTCD, MONA, TP guidelines (safety nets), OLDI	ATC12.1 ATC17	N/A
Verification of compliance and conformance monitoring (including certification, conformity assessment and oversight)	New EASA conformity assessment regulations (RMT.161) and updated guidelines	ECTL: CA guidelines, contingency guidelines, monitoring tools (Spectrum, Freq, RVSM, etc.) EU: Community specifications, NSA guidelines		N/A

Appendix E: Terms of reference of the two programmes to be launched

The content of this appendix refers to Measure 1, presented in Section 2. The proposal for these two terms of reference has been coordinated by the Network Manager.

E.1 Airspace Reconfiguration Programme

E.1.1 Purpose

The Airspace Reconfiguration Programme is created in order to deliver the redesign of the ECAC airspace to address future capacity and flight efficiency challenges. It is covered by the provisions of the Network Functions Implementing Regulation with respect to the ERND function. It will contribute to the fulfilment of the requirements arising from the relevant Single European Sky Implementing Rules and will address operational performance requirements for RP3. It will be established in full continuity with the actions already agreed through the NM's '7 Measures for 2019' and more specifically with the action 'addressing airspace structural bottlenecks'.

The Airspace Reconfiguration Programme will be implemented gradually and will take into consideration other major projects under development and implementation.

In accordance with Commission Regulation (EU) No 123/2019 (laying down the detailed rules for the implementation of ATM network functions), the Airspace Reconfiguration Programme will contribute to:

- delivering airspace solutions and interfaces required to facilitate operational interconnectivity within the ECAC airspace and at its interfaces to ensure the required level of operational performance;

- supporting the different operational stakeholders within the obligations that are placed on them in the development and implementation of ERNIP and in deploying relevant actions in accordance with the European ATM Master Plan.

E.1.2 Principles

The Airspace Reconfiguration Programme will organise its work based on the airspace design principles laid down in Commission Regulation No 123/2019, Annex I, Part C:

When developing the European Route Network Improvement Plan, the Network Manager, Member States and air navigation service providers, acting as part of functional airspace blocks or individually, shall, through cooperative decision-making, adhere to the following airspace design principles:

(a) the establishment and configuration of airspace structures shall be based on operational requirements, irrespective of national or functional airspace block borders or Flight Information Region (FIR) boundaries, and shall not be constrained by the division level between upper and lower airspace;

(b) the design of airspace structures shall be based on a transparent process allowing to consult the decisions made and understand their justifications and shall take into account the requirements of all users whilst reconciling safety, capacity, environmental aspects and having due regard to military and national security needs;

(c) the present and forecast traffic demand, at network and local level, and the performance targets shall be the input for the European Route Network Improvement Plan with a view to satisfying the needs of the main traffic flows and airports;

(d) ensure vertical and horizontal connectivity, including terminal airspace and the airspace structure at the interface;

(e) the possibility for flights to operate along, or as near as possible to, user required routes and flight profiles in the en route phase of flight;

(f) the acceptance for assessment and possible development of all airspace structures proposals, including Free Route Airspace, multiple route options and Conditional Routes (CDRs), received from stakeholders having an operational requirement in that area;

(g) *the design of airspace structures including Free Route Airspace and ATC sectors shall take into account existing or proposed airspace structures designated for activities which require airspace reservation or restriction. To that end only such structures that are in accordance with the application of the Flexible Use of Airspace (FUA) shall be established. Such structures shall be harmonised and be consistent with the largest possible extent across the entire European network;*

(h) *ATC sector design development shall commence with the required route or traffic flow alignments within an iterative process that ensures compatibility between routes or flows and sectors;*

(i) *ATC sectors shall be designed to enable the construction of sector configurations that satisfy traffic flows and are adaptable and proportionate to variable traffic demand;*

(j) *in cases where for operational reasons ATC sectors require to be designed across national or functional airspace block borders or FIR boundaries, agreements on service provision shall be established between the operational stakeholders concerned.*

The Network Manager, Member States, functional airspace blocks and air navigation service providers (the latter acting as part of functional airspace blocks or individually), shall, through cooperative decision-making, ensure that the following principles apply to airspace utilisation and capacity management:

(a) *airspace structures shall be planned to facilitate flexible and timely airspace use and management with regard to routing options, traffic flows, sector configuration schemes and the configuration of other airspace structures;*

(b) *airspace structures should accommodate the establishment of additional route options while ensuring their compatibility with the existing capacity considerations and sector design limitations.*

E.1.3   Criteria and assumptions

The Airspace Reconfiguration Programme will work on the basis of the following criteria and assumptions:

(a) design of an optimum airspace structure based on cross-border FRA and, if required, ATS route network below FRA;

(b) ensuring TMA connectivity (including TMAs covering several airports) and CCO/CDO operations, reorganisation of airspace above FL410, reconsideration (if necessary and in cooperation with all operational stakeholders) of the airspace classification (on the basis of the ICAO classification), gradual integration of new entrants, etc.;

(c) definition of optimum sectorisation;

(d) in order to avoid frequent airspace changes, utilisation of high traffic forecast to deliver a future-proof sectorisation;

(e) capacity and environment/flight efficiency performance;

(f) for design and operations, European airspace as a single airspace;

(g) addressing lower and upper airspace and TMA connectivity;

(h) including all the evolving military requirements and other national requirements;

(i) accommodating operational needs of airspace users to the greatest possible extent;

(j) ensuring early alignment and close cooperation with the computer flight-planning service providers;

(k) alignment with the ERNIP Part 1 technical specification for airspace design methodology and requirements;

(l) stepped implementation over RP3 converging towards the target plan.

E.1.4   Role

Within the framework provided by the SES regulations, the Airspace Reconfiguration Programme will ensure coordination for airspace design and development, planning and implementation of improved free-route airspace, ATS route network, optimised civil and military airspace structures, ATC sectors, and airspace utilisation and availability. The Airspace Reconfiguration Programme will carry out its work within the network CDM processes in cooperation with all operational stakeholders.

The Airspace Reconfiguration Programme shall:

a) ensure the development of an optimised airspace structure as a target plan;

b) cover aspects related to the development, optimisation and coordinated implementation of cross-border free-route airspace, ATS route network, en route and TMA airspace structures, ATC sectors, and airspace utilisation and availability;

c) ensure TMA connectivity (including TMAs covering several airports) and CCO/CDO operations, reorganisation of airspace above FL410, reconsideration (if necessary and in cooperation with all operational stakeholders) of the airspace classification (on the basis of the ICAO classification), gradual integration of new entrants, etc.;

d) ensure the development and consolidation at ECAC level of short-, medium- and long-term airspace development and implementation plans over the period 2020-2025;

e) ensure the availability of quick wins for implementation starting from summer 2020;

f) ensure the collection, consolidation and accommodation of civil and military airspace users' short-, medium- and long-term airspace design requirements and needs;

g) identify airspace design and utilisation-related operational bottlenecks and the mitigation solutions thereto;

h) identify operational resources required to deliver the required operational performance with the respect to the new sectorisation;

i) include, as required, operational stakeholders, including military, in fast and real-time simulation activities when those are deemed necessary;

j) include in its activities the coordination requirements arising from other airspace plans in the ECAC area.

E.1.5   Composition

The participants in the Airspace Reconfiguration Programme will be civil and military experts in airspace design and airspace utilisation, operational experts from ECAC member States and their ANS providers, civil airspace users and airport representatives. The membership will be constituted by the participants in the ERND network CDM processes.

E.1.6   Airspace Reconfiguration Programme completion criteria

The programme will be complete upon consistent implementation of cross-border FRA and optimised sectorisation for the entire ECAC airspace providing an appropriate response to the RP3 targets. Monitoring will be through NOP and ERNIP and through the specific RP3 monitoring processes.

E.2   Operational Excellence Programme

E.2.1   Purpose

The Operational Excellence Programme is created to complement the development and implementation of the new sectorisation projects. It is covered by the Network Functions Implementing Regulation through a large number of tasks included for the Network Manager. Its aim is to identify and implement best-in-class operational developments and deliver minimum common operational capabilities among all stakeholders. This will ensure the achievement of operational and technical harmonisation aligning with best-in-class performance and delivering the expected operational performance in line with the Airspace Architecture Study conclusions. It will contribute to the fulfilment of the requirements arising from the relevant Single European Sky Implementing Rules and will address operational performance requirements for RP3. It will be established in full continuity with the actions already agreed through the NM's '7 Measures for 2019' and more specifically with the action 'preparation of the Network Operations Plan 2019-2024'. It will also contribute to the implementation of some of the measures approved by the Network Management Board as part of the Network Operations Plan 2019-2024.

The Operational Excellence Programme will be implemented gradually and will take into consideration other major projects under development and implementation. The need to progress towards seamless cross-border operations will also address systems connectivity and interoperability, and the improvement of operational procedures.

In accordance with Commission Regulation (EU) No 123/2019 (laying down the detailed rules for the implementation of ATM network functions), the Operational Excellence Programme will contribute to:

- ensuring that the Network Strategy Plan and the Network Operations Plan contribute to the achievement of the Union-wide targets and associated local performance targets and monitor the implementation of the plans;

- initiating, supporting and coordinating cooperation between operational stakeholders in the development and implementation of operational actions to ensure efficient use of available airspace and capacity and reduce network delays;

- identifying in the Network Operations Plan all initiatives supporting the development of cross-border coordination and the provision of cross-border air traffic management and air navigation services, highlighting those on which the delivery of the Network Performance Plan is particularly dependent;

- providing a consolidated and coordinated approach to all planning and operational activities of the network, including monitoring and improvement of the overall network performance in order to improve network efficiency, interoperability and connectivity;

- supporting operational stakeholders in fulfilling the obligations that are placed on them, in deploying ATM or air navigation services (ANS) systems and procedures in accordance with the ATM Master Plan, in particular the common projects set up in accordance with Commission Implementing Regulation (EU) No 409/2013.

E.2.2   Principles

The Operational Excellence Programme will organise its work based on the provisions laid down in Commission Regulation No 123/2019, Article 9, 'Network Operations Plan':

The Network Manager shall establish a detailed Network Operations Plan, in cooperation with operational stakeholders to implement the Net-work Strategy Plan at operational level in the short and medium term through cooperative decision-making. The Network Operations Plan shall include, in particular:

- *operational actions that contribute to the achievement of the Union-wide performance targets and local performance targets in the performance scheme covering the calendar years of the reference period and the annual, seasonal, weekly and daily periods considering the latest traffic forecast and its evolution.*

- *The Network Operations Plan shall encompass operational actions concerning all network functions and military requirements, if these requirements are provided by Members States. Those operational actions shall be determined through cooperative decision-making and their mutual consistency shall be assessed by the Network Manager.*

- *If the Network Manager identifies operational constraints and bottlenecks preventing achievement of the Union-wide and local performance targets, it shall suggest additional operational actions. Such actions shall be determined through cooperative decision-making.*

- *Air navigation service providers and airport operators shall ensure that their plans are aligned with the Network Operations Plan and implement the operational actions included in the Network Operations Plan.*

E.2.3   Criteria and assumptions

The Operational Excellence Programme will work on the basis of the following criteria and assumptions:

(a) implementation of an optimised sectorisation across the ECAC;

(b) in order to avoid frequent operational changes, utilisation of a high traffic forecast to ensure the delivery of future-proof long-term performance;

(c) capacity and environment/flight efficiency performance;

(d) for design and operations, European airspace as a single airspace;

(e) addressing lower and upper airspace, with appropriate connectivity with the TMAs;

(f) ensuring TMA connectivity (including TMAs covering several airports) and CCO/CDO operations, reorganisation of airspace above FL410, reconsideration (if necessary and in cooperation with all operational stakeholders) of the airspace classification (on the basis of the ICAO classification), gradual integration of new entrants, etc.

(g) further progress with the harmonisation of A-FUA procedures, which should include the promotion of the utilisation by general air traffic of available/released 'special use airspace' (civil use of released airspace) in order to fully reap the benefits of the FUA concept;

(h) accommodating operational needs of airspace users to the greatest possible extent;

(i) ensuring early alignment and close cooperation with the computer flight-planning service providers;

(j) stepped implementation over RP3 in parallel with the implementation of optimised sectorisation.

The topics potentially to be covered are changes of operational procedures, letters of agreement, application of A-FUA and ATFCM, operational utilisation of resources, harmonised implementation of new operational concepts and technologies, smaller adaptations to systems, etc. The formal and detailed scope of the topics to be covered will be decided jointly and collaboratively by all operational stakeholders, as part of the project launch.

E.2.4   Role

Within the framework provided by the SES regulations, the Operational Excellence Programme will ensure coordination for the implementation of best practices and enhanced operational and technical concepts, potentially covering changes of operational procedures, letters of agreement, application of A-FUA and ATFCM, flight notification and coordination exchanges, operational utilisation of resources, harmonised implementation of new operational concepts and technologies, smaller

adaptations to systems, systems connectivity and interoperability, reasons for different levels of sectors throughput, etc. The Operational Excellence Programme will carry out its work within enhanced Network Operations Plan CDM Processes in cooperation with all operational stakeholders.

The Operational Excellence Programme shall:

a) ensure the further identification and consolidation of the topics to be included in its area of responsibility;

b) cover all aspects related to the topics listed above;

c) ensure the development and consolidation at local and network levels of short-, medium- and long-term operational development and implementation plans over the period 2020-2025;

d) ensure the availability of quick wins for implementation starting from summer 2020;

e) ensure the collection and consolidation of all requirements and best practices for the short, medium and long terms;

f) identify operational and technical bottlenecks and the mitigation solutions thereto.

E.2.5   Composition

The participants in the Operational Excellence Programme ll be civil and military experts, operational experts from ECAC Member States and their ANS providers, civil airspace users and airport representatives. The membership will be constituted by the participants in the Network Operations Plan network CDM processes. Appropriate cooperation will be secured with the SESAR Deployment Manager within the remit of its responsibilities.

E.2.6   Operational Excellence Programme completion criteria

The programme will be complete upon consistent implementation of the topics identified by the programme by all the concerned operational stakeholders. Monitoring will be through the enhanced Network Operations Plan CDM processes in cooperation with all operational stakeholders.

Appendix F: Link to SESAR Solutions delivery

F.1 Overview of core R&D in relation to the AAS

The core R&D that underpins the study is fully covered by the SESAR programme. In accordance with AAS Appendix E, a gap analysis has been performed to assess the degree of coverage of the scope of the solutions listed in AAS Appendix E against the outcome of the evaluations of the SESAR Wave 2 call and the updated information available at the time of writing this plan on the progress of the R&D activities in Wave 1.

- Fifteen solutions were already V3 mature at the end of SESAR 1.

- Fourteen solutions are expected to be V3 mature at the end of SESAR 2020 (five in Wave 1 and nine in Wave 2).

- Ten Wave 2 solutions are expected to reach V2 maturity at the end of SESAR 2020, and will need further validation beyond 2022 to reach V3.

- Five solutions have been defined to cover the content that is not addressed in the Wave 2 grants, and are currently in candidate status for the Wave 3 call specification. They will also reach V3 maturity beyond 2020.

Details of this snapshot [22], including the detailed list of solutions, their planned maturity date and their link to the AAS milestones, are described in this appendix in relation to the AAS Transition Plan.

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[21] For solutions in the R&D phase, this snapshot presents the expected maturity date based on the best information that is available to the SESAR JU at the time of writing this document.
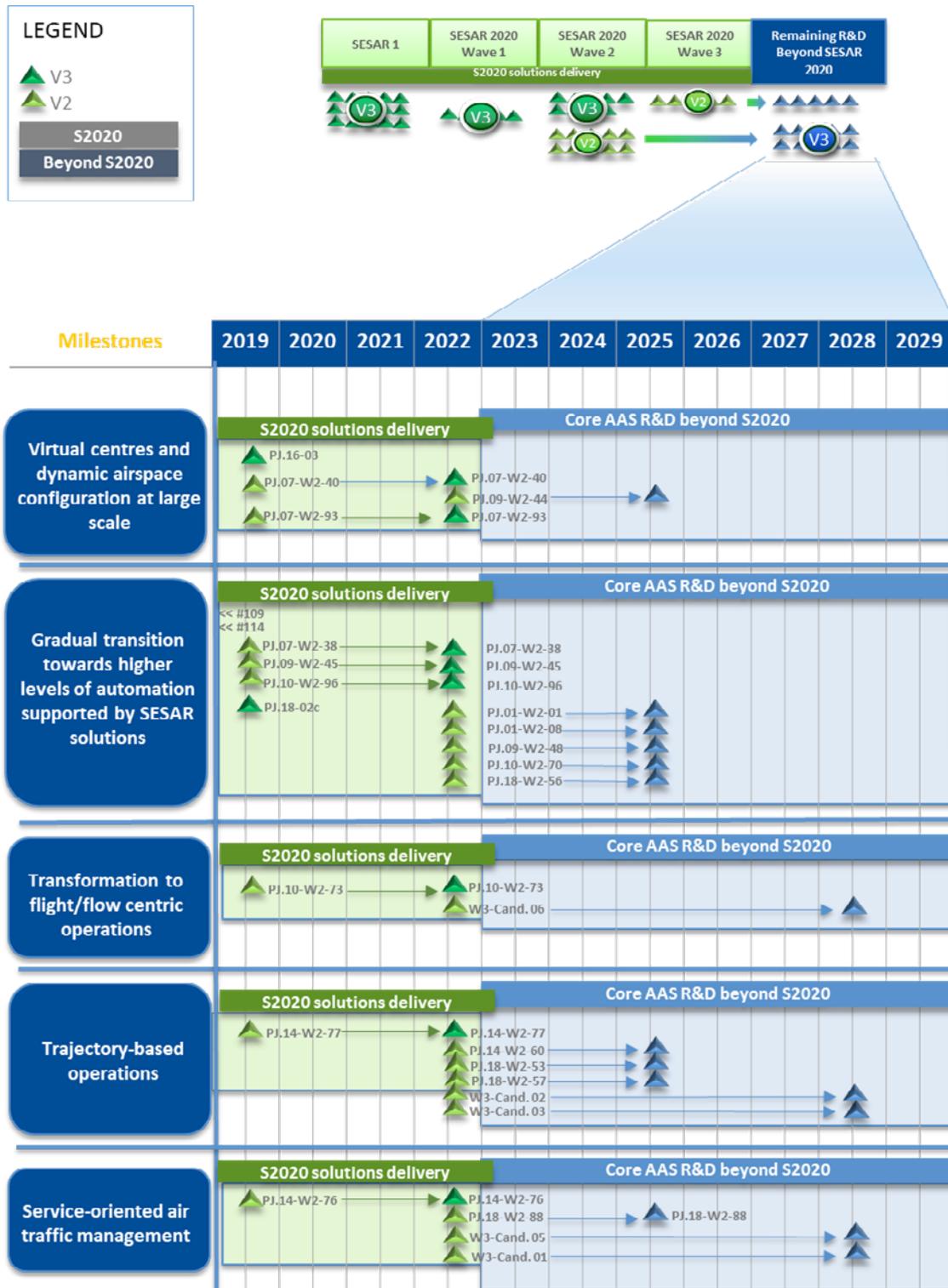
Figure 13: Overview of core R&D

F.2 Milestone 1: ECAC-wide implementation of cross-border free-route, air-ground and ground-ground connectivity

In Milestone 1, the implementation of two foundational technical enablers is essential in order to pave the way for the implementation of the revolutionary changes planned from Milestone 3 onwards:

- initial implementation of the first two air-ground data exchange technical solutions (solution #115, solution PJ.18-06a) is an essential foundation for the increase in the level of automation of the ATM systems that is planned from Milestone 3 onwards;

- ground-ground interoperability (solution PJ.18-02b) and data exchange (Solution #46, solution PJ.17-W2-101) are critical to defragment the technical dimension of ATM, an essential foundation to move to the ATM data service provision in a virtual centre context planned from Milestone 3 onwards.

Ground-ground interoperability makes it possible to extend arrival management beyond national borders (solution #05), improving the delivery of traffic to the busiest European airports.

The implementation of cross-border and cross-FIR free-route airspace (Solution #32, Solution PJ.06-01) provides maximum benefit when combined with the more efficient airspace management concepts enabled by A-FUA (solution #31). Improved tactical controller tools (solution #27) provide improvements to the automation support to controllers, increasing safety and ATC capacity.

All the solutions supporting Milestone 1 (Table 8) are part of the PCP except solutions #27 and PJ.17-W2-101.

Table 8: Solutions supporting Milestone 1

Solution ID	Title	Description	V3 date
#32	Free route through the use of direct routing	Direct routing is established within direct routing airspace with the aim of providing airspace users with additional flight-planning route options on a larger scale across FIRs such that overall planned leg distances are reduced in comparison with the fixed-route network and are fully optimised. Direct routing airspace is defined laterally and vertically with a set of entry/exit conditions where published direct routings are available. A direct routing is a published segment of a great circle between two published waypoints	2016 (SESAR 1)
#46	SWIM Yellow Profile	To foster interoperability within the future European ATM Network as envisaged by SWIM, the SESAR programme developed a series of documents covering aspects such as concepts, service descriptions, templates, governance and a series of technical resources such as models. The SWIM technological solution provides a coherent set of specifications providing essential requirements that are applicable to the standards used in the context of SWIM implementation. These documents are seen as the key elements in steering SWIM-enabled systems for ensuring the interoperability; AIRM; Semantic interoperability	ISRM: 3.1 Organisational interoperability	SWIM TAD, profiles, SWIM TI; SWIM TI and architecture shall enable technical interoperability. The SWIM registry aims to improve the visibility and accessibility of ATM information and services available through SWIM. It enables service providers, consumers and the SWIM governance to share a common view on SWIM. The SWIM registry provides consolidated information on services that have been implemented based on SWIM standards. Registry technical specification and registry concept of operation documents provide information and requirements required for the implementation of the SWIM registry	2016 (SESAR 1)

#115	Extended projected profile (EPP) availability on ground	Trajectory management is a key cornerstone of the ATM system. The better the trajectory prediction is, the better the whole ATM system will be. Nowadays there are multiple trajectory predictions held and maintained by those in the air and on the ground. They take into account different parameters (e.g. aircraft model, route/restrictions, operating preferences and weather forecast), leading to inconsistencies and different accuracy levels depending on flight phases. These inconsistencies lead to an inefficient ATM system as a whole. The 'EPP availability on ground" technological solution is a first step towards the full ground-air trajectory synchronisation required for the implementation of the targeted trajectory-based operations. It allows the provision to the ground systems of the aircraft view on the planned route and applicable restrictions known to the airborne system, together with the corresponding optimal planned trajectory computed on board and speed preferences. This information is automatically downlinked from the airborne flight management system via ADS-C datalink to the ground ATC unit that has subscribed to the needed service contract (e.g. EPP and speed schedule profile contracts) and made available to the controllers	2016 (SESAR 1)
#27	Enhanced tactical conflict detection & resolution (CD&R) services and conformance monitoring tools for en route	This SESAR Solution consists of innovative approaches that provide the en-route controller with two separation provision services. The first is an enhanced monitoring conformance service (MONA) for both tactical and planning controllers. Compared to the existing MONA, this SESAR Solution includes a new alert to take into account lateral deviation and the rate change monitoring in climbing and descending phases to minimise false alerts. Second, a conflict detection and resolution service is fully dedicated and designed for the tactical controller with a conflict detection service down to flight level 100. This service is based on effective clearances and specific ergonomics and use developed for the tactical controller, but also available and usable for the planning controller	2016 (SESAR 1)
#33	Free route through free routing for flights both in cruise and vertically evolving above a specified flight level	A user-defined segment is a segment of a great circle connecting any combination of two user-defined or published waypoints. Free-routing airspace is an airspace defined laterally and vertically, allowing free route with a set of entry/exit features. Within this airspace, flights remain subject to air traffic control	2016 (SESAR 1)
#PJ.06-01	Optimised traffic management to enable free routing in high- and very high-complexity environments	Optimised traffic management to enable free routing in high- and very high-complexity environments sees airspace users being able to plan flight trajectories without reference to a fixed-route network or published directs within high- and very high-complexity environments so they can optimise their associated flights in line with their individual operator business needs or military requirements. The solution provides a description of high- and very high-complexity cross-border free-routing environment in upper airspace (at the 2022 timeframe — as per PCP AF#3). The scope of the solution focuses on the improvement of aircraft-to-aircraft separation provision to enable free-routing operations in upper airspace in high- and very high-complexity cross-border environments (with minimum structural limits to manage airspace and demand complexity).	2019 (S2020 W1)
#PJ.18-02b	Flight object interoperability	The IOP activities include the definition of the IOP Solution, based on SESAR 1 Solution #28. The IOP scope has been divided into a basic scope, sufficient to deploy IOP in the core area of Europe, and the full scope, which provides additional IOP functionalities	2020 (S2020 W1)
#31	Variable-profile military reserved areas and enhanced (further automated) civil-military collaboration	Variable-profile military reserved areas and enhanced (further automated) civil-military collaboration	2016 (SESAR 1)
#PJ.18-06a	Air traffic control (ATC) planned trajectory performance improvement	The solution enhances the predictability of the network by incorporating the consideration of the eFPL in the trajectory prediction	2019 (S2020 W1)

| #05 | Extended arrival management (AMAN) horizon | This provides operational procedures and technical specifications for the integration of the information from arrival management systems operating out to an extended distance to provide an enhanced and more consistent arrival sequence. The system helps to reduce holding by absorbing some of the queuing time further upstream well into en route. It includes integration of traffic departing from within the AMAN horizon of the destination airport. In step 1, the newly affected en-route sectors are expected to contribute to the sequencing towards a single TMA | 2015 (SESAR 1) |
| #PJ.17-W2-101 | SWIM TI Green Profile for G/G civil-military information sharing | The solution aims at enabling ground-ground civil-military SWIM-based coordination at SWIM technical infrastructure level through SWIM profiles with an adequate quality of service, including (cyber)security/resilience, needed by military stakeholders and agreed by civil stakeholders | 2022 (S2020 W2) |

F.3 Milestone 2: Launch airspace reconfiguration supported by Operational Excellence Programme

The PCP AF4 (solutions #17, #18, #19, #20, #21, #37, #66) is already implemented, boosting network performance. A collaborative process involving all operational stakeholders (NM, ANSPs, airports and AUs) has been set up to enable airspace to be reconfigured irrespective of national borders on a periodic basis (typically seasonally) to best accommodate ECAC traffic flows.

An operational excellence programme is launched in order to identify best practices and capture quick wins (through small changes in operational procedures, smaller adaptations to systems, etc.) among all stakeholders and effectively support their implementation to reduce delays.

Table 9: Solutions supporting Milestone 2

Solution ID	Title	Description	V3 date
#66	Automated support for dynamic sectorisation	Automated support for dynamic sectorisation provides supporting tools to areas with high traffic density to evaluate the most suitable ATC airspace configuration (sectors). Dynamic capacity management allows capacity to be adapted to traffic load by grouping and de-grouping sectors and managing the staff resources accordingly. Unused latent capacity can occur at all flow management positions during peak traffic times. Current tools facilitate the detection of overload but do not offer better options to deal with it	2013 (SESAR 1)
#17	Advanced short ATFCM measures (STAM)	Advanced STAM supported by automated tools for hot-spot detection at network level enable ANSPs to optimise traffic throughput. Advanced STAM are built on the basis of STAM implementation (hot spot, coordination tool, occupancy traffic monitoring values). The planned enhancements focus on improved predictability of operations, including sib/iRBT-supported traffic and complexity prediction, weather, airport operations (departure sequences, ground handling, gate management, runway usage), what-if function and network capabilities	2016 (SESAR 1)
#20	Collaborative NOP	A collaborative NOP information structure (information model, classification by types of actions, influencers, performance objectives, relationships between actions, objectives, issues, etc.) will be available. The collaborative NOP will be updated through data exchanges between Network Manager and stakeholders' systems to the required level of service. This will enable the Network Manager and stakeholders to prepare and share operational decisions (e.g. TTA, STAM) and their justifications in real time	2016 (SESAR 1)

#18	CTOT and TTA	Transition from CTOT to CTOT and TTA: TTA should be considered at Network Manager level for traffic-planning activities (ATFCM measures) and distribution of the TTA through NOP in particular to the airport of destination	2016 (SESAR 1)
#19	Automated support for traffic complexity detection and resolution	Automated tools support the ATC team in identifying, assessing and resolving local complexity situations. It relies on a real-time integrated process for managing the complexity of the traffic with capability to reduce traffic peaks through early implementation of measures for workload, balancing solutions based on traffic complexity assessment and on individual traffic complexity	2016 (SESAR 1)
#37	Extended flight plan	The extended flight plan is an extension of the ICAO 2012 FPL. New information encompasses: • the 4D trajectory as calculated by the FOC flight-planning system in support of the generation of the operational flight plan; the 4D trajectory information is not limited to 4D points but contains additional elements for each point of the trajectory such as speeds, and aircraft mass; • flight-specific performance data: the climbing and descending capabilities of the aircraft specific to the flight. A short-term use case for extended flight plan is that the solution develops the concept and the use of the extended flight plan to improve the process of validation of flight plans by the Network Manager, in particular by reducing the number of flight plan rejections resulting from the low resolution of the ICAO 2012 flight plan.	2016 (SESAR 1)

F.4 Milestone 3: Virtual centres and dynamic airspace management at large scale

In the technical domain, Solution PJ.16-03 already provides in Wave 1 a solution to technically support the decoupling of FDPS services and the CWP though the virtual centre concept, enabling initial consolidation of services for increased cost efficiency. Consolidation of FDPS services starts within ANSP industrial partnerships that use the same ground system providers, and is gradually extended by the creation of competitive providers of FDPS services from which ANSPs contract their services.

In the operational domain, solution PJ.10-W2-93 covers the operational aspects related to the delegation of airspace and contingency, increasing the resilience of the ATM system and enabling increased ATC capacity though the capacity-on-demand service and through the release of ATCO hours at valley hours enabled by the consolidation of ATC facilities at periods of low demand (e.g. nights).

A Wave 3 candidate solution (W3-C01) has been defined to develop system support with the objective of increasing the average number of sectors/configurations for which a controller can be endorsed. This increased flexibility facilitates the allocation of controllers to where there is traffic demand within a single ANSP and across ANSPs (through the capacity-on-demand concept), and the consolidation of ATC facilities during periods of low demand.

Building on the PCP functionalities implemented in Milestone 2, innovation in airspace management continues to increase efficiency through the introduction of dynamic airspace configurations (Solution PJ.07-W2-44) combined with improved civil-military coordination through the management of mission trajectories integrated with dynamic mobile area types 1 and 2 (Solution PJ.07-W2-40).

Table 10: Solutions supporting Milestone 3

Solution ID	Title	Description	V3 date
#PJ.16-03	Work station, service interface definition and virtual centre concept	The work station, service interface definition and virtual centre concept will provide an operating environment in which different ATS units, even across different ANSPs, will appear as a single unit and will be subject to operational and technical interoperability. It includes developing the ATSU architecture from a service-oriented approach with a focus on the technical services and common interfaces. Based on the virtual centre concept, the CWP/HMI needs to interface with one or more information service providers or consumers. A high-performing and reliable underlying communication infrastructure may be needed. This solution encompasses en route and TMA and airport/tower environments	2019 (SESAR 2020 W1)
#PJ.07-W2-40	Mission trajectories management with integrated dynamic mobile areas type 1 and type 2	The objective of the solution is to improve the use of airspace capacity for both civil and military users and the efficiency of airspace management by introducing more automation and increased flexibility in civil-military coordination. The solution delivers improvements to the planning phase of the mission trajectory, including the connection of MT management with the booking of ARES (in the context of this solution, dynamic mobile area type 1 and type 2), for which the WOC will be the key actor. The coordination between WOC and regional NM is a key element of this solution	2022 (SESAR 2020 W2)
#PJ.09-W2-44	Dynamic airspace configurations (DACs)	The objective of the solution is to improve the use of airspace capacity for both civil and military users by increasing granularity and flexibility in airspace configuration and management within and across ANSPs' areas of responsibilities. This solution will address the integration of concepts and procedures to allow flexible sectorisation boundaries to be dynamically modified based on demand. This includes potential implications for ATCO licences, international boundaries and potentially IOP and air-ground multi-datalink communication capabilities	Post- SESAR 2020
#PJ.10-W2-93	Delegation of airspace among ATSUs	The objective of this solution is to explore the different possible delegation of airspace among ATSUs based on traffic/organisation needs (either static, on a fixed-time transfer schedule (day/night), or dynamic, e.g. when the traffic density is below/over a certain level) or on contingency needs. The solution covers an operational thread, which aims to define and validate the different types of delegation of airspace, and a technical thread, which aims to specify the impacts of the operational thread on the services defined in the virtual centre concept	2022 (SESAR 2020 W2)

F.5 Milestone 4: Gradual transition towards higher levels of automation supported by SESAR Solutions

These solutions cover the required automation support to enable an efficient transition between en route and the extended TMA (PJ.01-W2-08), to improve the performance of the network (PJ.18-02c, PJ.07-W2-38, PJ.09-W2-45, PJ.09-W2-48, PJ.09-W2-45) and ATCO support tools to increase the airspace capacity (PJ.10-W2-70, PJ.10-W2-96, PJ.18-W2-56).

In the CNS domain, the IRIS precursor provides additional datalink capabilities to enable the increased air-ground data exchange (solution #109), and ADS-B/WAM cooperative surveillance is implemented (solution #114), in particular in support of the increased resilience of the surveillance service.

Implementation of the increased automation support should not need incentivisation (because it increases the productivity of ANSPs, it is expected to have a positive business case, and therefore not need incentivisation). This applies also to the implementation on the ground of the IRIS precursor; on the airborne side, the IRIS precursor solution may need incentivisation. Incentivisation for the implementation of Solution #114 may be necessary.

Table 11: Solutions supporting Milestone 4

Solution ID	Title	Description	V3 date
#109	Air traffic services (ATS) datalink using Iris Precursor	The Iris Precursor offers a viable option for ATS datalink using existing satellite technology systems to support initial four-dimensional (i4D) datalink capability. The technology can be used to provide end-to-end air-ground communications for i4D operations, connecting aircraft and air traffic management ground systems	2016 (SESAR 1)
#114	Cooperative surveillance ADS-B/WAM	Air traffic surveillance systems use both cooperative and non-cooperative techniques to locate aircraft. Whereas non-cooperative techniques rely on the reflection of energy directed at the aircraft, cooperative techniques require the aircraft to carry a transponder or transmitter device. Systems using the signals broadcast from such transponders/transmitters are classified as cooperative independent technology, as the ground surveillance systems derive all surveillance information from the decoded message content to determine aircraft identity and 3D position. Systems, such as ADS-B, in which the aircraft transmits its own position are classified as a cooperative dependent technology	2016 (SESAR 1)
#PJ.18-02c	eFPL supporting SBT transition to RBT	This technological solution will look at the distribution of eFPL information to ATC systems, and at the possible improvements of the alignment of AUs' and NM's trajectories, especially concerning use of PTR s and standard instrument departure or standard arrival route allocation	2019 (S2020 Wave 1)
#PJ.01-W2-01	Next-generation AMAN for 4D environment	This solution will provide enhancements to the arrival management systems and procedures in the context of digitalisation in ATM: uplink of AMAN constraints, uplink of a standard arrival route or custom arrival route to the aircraft via ATN B2 from the ATSU, potential use of maximum descent speeds, etc. It investigates strategies to increase the use of managed/automatic mode for flights handled by TTL/TTG during sequencing, improved consideration of downlinked aircraft data by AMAN algorithms, use of machine learning for the refinement of AMAN algorithms, etc.	Post-SESAR 2020
#PJ.01-W2-08	Dynamic E-TMA for advanced continuous climb and descent operations and improved arrival and departure operations	The objective of this solution is to improve descent and climb profiles in busy airspace, and the horizontal flight efficiency of arrivals and departures, while at the same time ensuring traffic synchronisation, short-term DCB and separation. This requires a very broad scope, which includes advances in airspace design, development of ground tools, and development of ATC and airborne procedures	Post-SESAR 2020
#PJ.07-W2-38	Enhanced integration of AU trajectory definition and network management processes	The objective of this solution is to reduce the impact of ATM planning on airspace users' costs of operations, by providing them with better access to ATM resource management and enabling them to cope better with ATM constraints. The solution will improve airspace users' flight planning and network management through improved FOC participation in the ATM network collaborative processes in the context of FF-ICE and its potential developments	2022 (SESAR 2020 W2)
#PJ.09-W2-45	Enhanced network traffic prediction and shared complexity representation	This solution aims to improve the accuracy of the network manager traffic prediction from medium-term planning phase (D-2) to execution (included), relying in particular on new trajectory management features such as the preliminary FPL. It will adapt existing methodologies and algorithms for demand prediction and regional complexity assessment	2022 (SESAR 2020 W2)
#PJ.09-W2-48	Digital integrated network management and ATC planning (INAP)	The SESAR solution 'digital INAP' aims to fill the gap between the management of traffic flows at network level (dDCB) and the control of flights in individual sectors. The solution develops and integrates local functions and associated tools, roles and responsibilities, providing an automated interface between local NM and ATC planning to assist controllers in alleviating traffic complexity, traffic density and traffic flow problems	Post-SESAR 2020

#PJ.10-W2-70	Collaborative control and multi-sector planner (MSP) in en route	This solution addresses the collaborative control with unplanned boundaries concept, in which the traditional requirement to coordinate traffic at all sector boundaries is waived for an area covering two or more sectors. In case it is not completed in Wave 1, the solution's scope also covers the development, for the en route environment, of the concept of operation and the required system support, e.g. coordination tools for operating in a team structure where a planner has responsibility for the airspace under the executive control of two or more independent executive controllers (i.e. is a multi-sector planner or MSP). The MSP is able to adjust the internal (executive) sector boundaries so that workload is balanced between the executive controllers	Post-SESAR 2020
#PJ.10-W2-96	HMI interaction modes for ATC centre	This solution addresses the development of new HMI interaction modes and technologies in order to minimise the load and mental strain on controllers in the ATC centre. The SESAR solution will consider modern design and development approaches and methodologies such as modularity, SoA and adaptive automation. The new HMI interaction modes include the use of in-air gestures, attention control, user profile management systems, tracking labels, virtual and augmented reality, etc.	2022 (SESAR 2020 W2)
#PJ.18-W2-56	Improved vertical profiles through enhanced vertical clearances	The objective of this solution is to develop an automation support for ATCOs to issue vertical constraints that support more efficient flight profiles while ensuring separation provision. As a first step, for flight still in climb, enhanced prediction of vertical profile data are presented to ATCOs to facilitate decision-making. In a second, more advanced step, the ATC system would generate proposals for conflict-free clearances that take expected aircraft performance into account, which can be uplinked to the flight crew by ATCO	Post-SESAR 2020

F.6 Milestone 5: Transformation to flight-/flow-centric operations

For this milestone, the initial implementation of the flight-centric concept as validated in Wave 2 is planned (PJ.10-W2-73). The Wave 1 results suggest that the concept will provide value in low- and medium-density en route environments. In some cases a flight-centric area can be larger than the coverage of a single VHF frequency; it is made possible by the wide area communication concept, included in the solution.

The PJ.10-W2-73 flight-centric concept requires one frequency per ATCO, which, considering that there are no planners in flight-centric operations, means that the concept requires more frequencies than sectored ATC. The frequency-sharing concept included in the follow-up solution enhanced flight-centric operations (W3-C06) will mitigate this issue, and allow the introduction of the capacity-on-demand service in a flight-centric environment through the innovative flight-centric distributed team (delegation of workforce instead of delegation of airspace).

Table 12: Solutions supporting Milestone 5

Solution ID	Title	Description	V3 date
#PJ.10-W2-73	Flight-centric ATC and improved distribution of separation responsibility in ATC	The solution covers a concept that consists of assigning aircraft to ATCOs without reference to geographical sectors, and having the aircraft controlled by that same ATCO across two or more geographical sectors. The solution requires flight-centric specific allocation, visualisation (traffic filtering), coordination tools (e.g., in the event of a conflict, establish which controller is responsible for its resolution) and, for high traffic densities, advanced CD&R tools (which are not specifically flight-centric). The solution also covers the concept of collaborative control with planned boundaries in which sectors are retained as they are today, with the aircraft being assigned to a sector according to its geographic location. The boundaries between sectors have planned coordination conditions as in current operations, but with some additional flexibility by allowing controllers to issue clearances without prior coordination to aircraft in a different sector	2022 (SESAR 2020 W2)
W3-Candidate 06	Enhanced flight-centric operations	The Wave 3 solution includes improvements beyond the Wave 2 flight-centric solution, including in particular the distributed flight-centric team, the share-frequency concept and the flight-centric solution in challenging high-density/high-complexity environments	Post-S2020

F.7 Milestone 6: Trajectory-based operations

Trajectory-based operations are central to ICAO and SESAR's vision of efficient and safe ATM operations based on the optimised, accurate and constantly updated trajectory. It includes a list of enablers (PJ.14-W2-60, PJ.14-W2-77) in support of new air-ground information-sharing processes (W3-C03 and W3-C02). Innovative controller tools in support of the TBO concept will be rolled out (PJ.18-W2-53, PJ.18-W2-57).

Table 13: Solutions supporting Milestone 6

Solution ID	Title	Description	V3 date
#PJ.14-W2-60	FCI terrestrial data link and A-PNT enabler (L-DACS)	This solution constitutes the future terrestrial air-ground and air-air datalink solution, which is one of the ICAO technologies, and supports the increasing ATM performance requirements (due to the growth in air traffic and its complexity). L-DACS constitutes a potential component of the A-PNT to support positioning and navigation requirements in PBN/RNP operations in case of a GNSS degradation or outage	Post-SESAR 2020
#PJ.14-W2-77	FCI services	This Solution will allow the real-time sharing of trajectories, timely access to ATM data and information services, and support to SWIM. The communication services will support ATN-B1 and ATN-B2 ATS services, and be expandable to support advanced ATM applications such as ATN-B3 ATS services. It will support AOC services and digital voice (voice over internet protocol) services. The communication services will be delivered using ATN/IPS and will allow interoperability with ATN/OSI protocols	2022 (SESAR S2020 W2)
#PJ.18-W2-53	Improved ground trajectory predictions enabling future automation tools	This solution focuses on the operational validation of improved CD&R tools. The main goal is to increase the quality of separation management services, reducing controller workload and separation buffers and facilitating new controller team organisations. The foundation is the improvement of the ground TP (EPP data beyond weight and CAS, known MET data or new MET data and capabilities, etc.)	Post- SESAR 2020
#PJ.18-W2-57	RBT revision supported by datalink and increased automation	This solution aims to support a continuous increase in the amount and the usefulness of information shared between air and ground, and of the level of automation support to controllers and pilots, e.g. towards the automatic uplink of clearances with or without previous controller validation and towards increased use of the auto-load to FMS of uplinked clearances and of managed/automatic mode by the flight crew	Post- SESAR 2020
W3-Candidate 02	Enhanced operations through advanced ATN-B3 digital voice and datalink controller/pilot communications	This solution covers the operational dimension of PJ.14-W2-60, which is working on the technical infrastructure e.g. LDACS. It includes the extension of the use of datalink to the lower airspace and the introduction of the single connection to ATC concept, whereby voice, datalink and ADS-C handovers will be transparent to the flight-crew	Post- SESAR 2020
W3-Candidate 03	Improved operational efficiency through ATN-B3 automatic air/ground data synchronisation	This solution covers the development of automatic air-ground synchronisation, as well as the development of the linked ground and airborne procedures and systems. It will dramatically increase the on-board use of managed mode and auto-loading of ATC clearances. ATN-B3 will include the single connection to ATC concept, whereby voice, datalink and ADS-C handovers will be transparent to the flight crew	Post- SESAR 2020

F.8 Milestone 7: Service-oriented air traffic management

Full implementation of the decoupling of air traffic services, ATM data services (PJ.18-W2-88), integration services and geographically fixed services will take place by this milestone. This structural change of the European ATM system will increase its flexibility and resilience, and allow scalability. This also includes the definition of a performance- and service-based CNS infrastructure (PJ.14-W2-76).

A Wave 3 candidate solution (W3-C01) has been defined to develop system support with the objective of increasing the average number of sectors/configurations for which a controller can be endorsed. This increased flexibility facilitates the allocation of ATCO resources across the network, thereby supporting the capacity-on-demand service.

The digital voice service (W-C05) will prevent the lack of availability of VHF frequencies from stopping traffic growth, and will support the digitalisation objective. The implementation of digital voice will be smooth thanks to the flexibility made possible by flight-centric operations (Milestone 5), which makes it possible that equipped and non-equipped aircraft will be able to fly in the same airspace during the transition phase.

Table 14: Solutions supporting Milestone 7

Solution ID	Title	Description	V3 date
#PJ.14-W2-76	Integrated CNS and spectrum	This solution addresses the CNS's cross-domain consistency in terms of robustness, spectrum use and interoperability, including the civil-military aspects, through the provision of a global view of the future communications, navigation and surveillance services and the definition of the future integrated CNS architecture (and the CNS spectrum strategy)	2022 (SESAR 2020 W2)
#PJ.18-W2-88	Trajectory prediction service	This solution is a technical service conceived as being provided to European ANSPs, AUs, airport operators, military and the Network Manager (NM) in support of trajectory operations. The solution is intended to provide a single point of truth for a specific trajectory in the time frame from creation in long-term pre-flight planning through to the flight execution phase. The solution is not intended to replace today's flight data-processing systems and consequently the service can be used as an input to ATC systems but not used directly for control purposes	Post- SESAR 2020
W3-Candidate 05	L-DACS voice and common digital information distribution mechanisms	This solution supports ATN-B3. It includes the geographically independent controller-pilot digital voice communication service, and the development of the architecture for routing the distribution of information (be it voice or data) from originator to recipient	Post- SESAR 2020
W3-Candidate 01	Sector-independent controller validations	This solution makes it possible to reduce the number of hours required for a controller to maintain the endorsement to work in a sector or flight-centric area, thereby making it possible that he or she be endorsed for more sectors than today, thereby increasing the flexibility in the allocation of controller resources, and allowing a wider implementation of the capacity-on-demand service	Post- SESAR 2020

F.9   R&D complementary to the AAS

The AAS has been limited in scope to focus on the upper airspace only. Given this, it cannot replace the European ATM Master Plan, which remains the structuring, reference document for ATM modernisation with a broader scope and longer-term vision. Consequently, the AAS architecture remains embedded in a bigger development of air traffic management.

- With the overall increase of air traffic, congestion at airports and their corresponding terminal airspace will increase. Future R&D will aim to increase airport and TMA capacity.

- RPAS will be integrated into the ATM environment. Research is need to define and validate the mechanisms for RPAS collision avoidance and effective situational awareness of the remote pilot. The objective is to enable IFR RPAS operating from dedicated airfields to routinely operate in airspace classes A to C as general air traffic without a chase plane escort. This requires the development of ATC procedures, adaptations to the flight-planning processes, contingency, etc. Technical capabilities and procedural are required to allow IFR RPAS to

comply with ATC instructions. New procedures and tools are required to allow ATC to handle IFR RPAS in a cooperative environment in full integration with manned aviation.

- New entrants represent an increasing body of players that are seeking to implement new aviation concepts in airspace where there is currently little managed activity. The scope covers U-space to manage drones, typically in airspace below 500 feet, including over cities, and higher airspace operations, in airspace above levels used by existing airspace users, typically above FL660. These actors are often new to aviation, and use or intend to use new technologies and air vehicle concepts, experimental prototypes, or sometimes aircraft still in the R&D phase (e.g. supersonic or hyper-sonic projects), manned and unmanned, for which there are currently few or no regulation, standardisation or certification requirements in place.

- The objective of U-space, whose development has already started in SESAR 2020, is to create the building blocks of a system that provides services that are scalable for large numbers of small drones, creating an ecosystem that is very different from ATM to meet all drone-specific requirements, but that is nevertheless seamlessly integrated with ATM.

- There is a need to guarantee that the implementation of the AAS vision is not at the expense of equity and access for emerging demand such as new entrants, U-space and IFR RPAS, as well as any future development in the demand for general aviation and rotorcraft.

- New technologies will arise, complying with the CNS performance-based approach as defined in the AAS. Building on the success of the European Geostationary Navigation Overlay Service and IRIS, this may include, but is not certainly not limited to, the further extension of performance-based satellite-based services.

- Progress made in the field of machine learning and artificial intelligence will open the door to a multitude of innovative applications in ATM. Tasks will be performed collaboratively by hybrid human-machine teams, in which advanced adaptable and adaptive automation principles could dynamically guide the allocation of tasks.

- New environmental solutions may be researched and developed to target a reduction in noise and/or fuel burn. Potential research may target green taxi operations and formation flying for civil aviation, and also controller tools targeting specific environmental improvements.

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