Second draft of the SESAR 2020 R&I Programme

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Edition 0.21

This document is the second draft programme document, developed with the contribution from all existing SJU Members in view of the launch of the first step of the procedure for the selection of the candidates to become Members of the SESAR Joint Undertaking (hereinafter SJU or Joint Undertaking). The Administrative Board is required to take note of this document that may be further developed by the SJU for the call preparation.

Disclaimer

This document is the second draft programme document, developed with the contribution from all existing SJU Members in view of the launch of the first step of the procedure for the selection of the candidates to become Members of the SESAR Joint Undertaking (hereinafter SJU or Joint Undertaking). It may be further developed by the SJU for the call preparation.

From the work performed in the task forces involving the SJU, it's Founding Members, existing Members and their Associates; this document captures a revised draft of the SESAR 2020 Programme context, structure and content.

Once the selection process of the candidate Members to the SJU is completed, the SJU together with these entities and the European Commission as necessary will review this draft Programme in view of its definition to underpin the activities to be performed during SESAR 2020.

Executive Summary

On 16 June 2014, the Council of Ministers of the European Union adopted the regulation amending Council Regulation (EC) 219/2007 and which resulted mainly in the extension of the legal existence of the SESAR Joint Undertaking until 31 December 2024. In addition, the amending regulation entrusted the SJU with EUR 585 million from Horizon 2020 to execute and deliver the SESAR Research & Innovation (R&I) Programme 2020 to contribute achieving the Single European Sky and more particularly the European ATM Master Plan.

Set up in 2007, following the SESAR Definition Phase, the SJU is a public-private partnership which manages the Single European Sky Air Traffic Management Research (SESAR) Programme. The SJU is established by the European Union together with Eurocontrol and involves the active participation of the European and non-European ATM industry.

This document outlines the main context, structure and content of the activities that are intended to be performed under the "SESAR Research & Innovation 2020".

SESAR R&I 2020 recognizes that the world is different today compared to 2007 when the emphasis had to be placed on averting congestion of the European sky. It is forward looking, ambitious and more focused on delivering innovation (SESAR solutions) that will make the ATM system more effective in a number of areas, namely high performing airport operations, advanced air traffic services, optimised ATM network services and enabling the aviation infrastructure. It is also innovative itself in the way the Programme will be run with, for example, a greater emphasis on bridging R&I with deployment by demonstrating the performance of innovative solutions at a significantly larger scale and in real operating environments. Another example will be reduced complexity, so that partners can dedicate more time on research and innovation and less time on its management.

SESAR R&I 2020 was developed having the shared vision of the evolution of the ATM System in mind which is captured in the European ATM Master Plan. The Programme is building on strong foundations where SESAR has notable successes. To name but a few: SESAR will continue to deliver solutions that are mature for industrialisation and deployment on a yearly basis through Releases and continue to be open by involving third parties (e.g. airspace users, military, staff associations and regulators). The SJU will ensure that the European ATM Master Plan remains the overarching reference point for SESAR Research, Innovation and Deployment to bring innovations successfully to the markets while recognizing the need to collaborate with other regions of the world.

SESAR R&I 2020 will result in an overall budget in the order of magnitude of EUR 1.5 billion, EUR 500 million will be provided by the European Union and complementary funding provided by Eurocontrol and industry. A further EUR 85 million are earmarked for specific exploratory research activities, particularly designed to attract universities, public institutions, SMEs and industry to ensure a continuous flow of research results moving towards innovation and deployment.

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1 Introduction & Context

This document contains the context, objectives and high-level description of the SESAR 2020 Research and Innovation (R&I) Programme. This document represents an updated draft of the initial SESAR Programme 2020 established in 2012. It is an additional step in the process of establishing the SESAR Partnership for 2020. The SESAR Joint Undertaking (SJU) will be responsible for managing R&I within the new Partnership as well as open calls for participation under Horizon 2020. The SJU shall deliver research results from the scientific ideas work needed to achieve TRL1 through to TRL7+ demonstration activities ready for industrialisation and deployment.

Key principles for the Programme 2020 were agreed with the SJU Programme Committee and inspired the High Level content. This work used as its basis the document previously developed to support SJU Extension decision-making.

The established key principles cover master planning, programme setup, programme output and the partnership.

<u>Master Planning</u>

The **ATM Master Plan** is and shall remain the overarching **reference,** with:

- A need to revisit performance expectations,
- Dissemination of results beyond Partnership,
- Consistency between Master plan 201x and SESAR 2020 to be ensured,
- Flexibility to adapt the Programme and the Master Plan based on performance needs and research results over 2-3 year cycles.

The SJU which is entrusted by the Council Regulation with the overall responsibility for the execution of the European ATM Master Plan shall ensure a very strong coordination with the Deployment Manager including reconsidering the current setup for the maintenance activities, with particular regard to the level 3 of the Master Plan.

<u>Programme setup</u>

Building on current experience & results, the **Programme 2020** shall:

- Take a pragmatic balance between covering the whole and what is feasible, while ensuring adequate ambition.
- Be defined and launched using the expected level of completion and results of the current programme.
- Include a definition of activities for 2-3 years and an overall high-level commitment to the remainder using a simplified offer procedure.
- Strengthen the performance driven approach, both top-down and bottom-up to enable network benefit assessment and extrapolation of local benefits to other scenarios.
- Establish continuity and a clear transition path between Exploratory Research, Applied & Pre-Industrial Research and Very Large Scale Demonstration activities.
- Conduct and control validation at all maturity levels.
- Establish clear governance mechanisms for the different phases of Research & Innovation.

<u>Programme Output</u>

The **Programme 2020** shall:

- Be based on agreed priorities thus focussing on facilitating & de-risking deployment.
- Establish clear Programme output and ensure a commitment towards standardisation (where relevant), industrialisation, deployment (including common projects) and SES performance in particular through SJU engagement with EUROCAE and ICAO.

- Conduct Validation & Demonstration in order to secure deployment of operational improvements & technology enablers in the shortest possible time.
- Ensure worldwide interoperability through a set of coordinated activities with ATM similar programmes outside of Europe (including NextGen).

1.1 Context and background

1.1.1 Policy & EU Context

The SJU was established on 27 February 2007 by Council Regulation (EC) 219/2007, as last modified by Council Regulation (EC) 1361/2008 (SJU Regulation). The mission of the SJU, created under Article 187 of the Treaty on the Functioning of the European Union and co-founded by the European Union and Eurocontrol, the founding members, is to ensure the modernisation of the European air traffic management system by coordinating and concentrating all relevant research and development efforts undertaken by its members and the related financing.

In particular, the SJU is responsible for the implementation of the European ATM Master Plan and for carrying out specific activities aiming at developing the new generation of air traffic management system capable of ensuring the safety and fluidity of air transport worldwide over the next thirty years. A substantial part of the benefit of the SESAR Programme lays in the involvement of most of the European ATM stakeholders for the development of the operational and technical solutions which best meet the objectives set out in the European ATM Master Plan. Following the launch of the “call for expression of interest to become member of the SJU” by the European Commission on 27 June 2007 and the ensuing negotiation conducted, the membership process was finalised with the selection of fifteen organisation representing industry and at large extent stakeholders of the European ATM.

As such, the SESAR (Single European Sky ATM Research) programme constitutes the technological and operational research pillar of the SES (Single European Sky) initiative to modernise the European Air Traffic Management system in accordance with the European ATM Master Plan, currently the European ATM Master Plan 2012.Every year over 1.6 billion passengers take one of Europe’s annual 10 million flights - expecting to have a safe and smooth journey without any delays or cancellations and to arrive on time at their destination with luggage in hand. Meeting these expectations is the job of Europe’s Air Traffic Management (ATM) system, which up until now, has safely and effectively managed the flow, movement and density of traffic in our skies. But with flights forecasted to increase to 16.9 million by 2030, the current ATM system needs to keep pace and be further updated with latest technologies and operational procedures in order to avoid fragmentation and cater for more flights in an efficient, safe and environmentally-friendly manner. A modernised air transport system, characterised by innovative technology and the timely delivery of competitive products and services, will be vital for the European economy and society, and the cohesion of Europe.

It is necessary to continue research and innovation on air traffic management (ATM) beyond 2016, and in particular, the coordinated approach in ATM research and innovation in the context of the SES to achieve the performance targets there defined. Consequently, on the 10th of July 2013, a legislative proposal for extending the SJU beyond 2016 for the new activities highlighted in the ATM Master Plan from 2014 to 2020 with multiannual funding under the Union’s new financial framework, Horizon 2020 Programme for Research and Innovation (H2020, 2014-2020) was adopted by the European Commission. The proposal was supported by an ex ante evaluation which indicated that based on the success of the SJU management of the SESAR Programme, the balance of resources allocated to the different phases of the R&I cycle needed to be reviewed. Inter alia, the ex-ante emphasised that better efforts need to be further invested exploratory research in order to keep innovative ideas flowing from various universities, research establishments and SMEs via their “Centres of excellence” and “Blue sky research” activities.

The 2020 SESAR Programme will generate an innovation pipeline towards deployment by demonstrating the viability of the technological and operational solutions already developed within the SESAR Programme (2008-2016) in larger and more operationally-integrated environments. At the same time, SESAR 2020 will prioritise research and innovation in a number of areas, namely high performing airport operations, optimised ATM network services, advanced air traffic services and the enabling aviation infrastructure, providing a performing ATM system to air vehicles and airspace users. SESAR 2020 will retain its founding members the European Union and Eurocontrol (broadly under the key principles already established in the agreement with the SJU and with the possibility of eligibility for co-financing of certain activities), while offering its current 16 industry members the opportunity to continue, as well as for new members to join.

In the context of aviation the Clean Sky project will be performing R&I activities oriented on the air vehicle and its environmental performance whilst the SJU is responsible for the System and integration of all vehicles and types into an operations network delivering performance improvements defined in the SES legislation and aligned with the targets contained within. Consequently, efficient and effective coordination between the SJU and Clean Sky will be required.

1.1.2 Achievements to date

Since its establishment, the SJU has established a formal Administration, Programme Management, Operations Management and Technical Competence in order to coordinate and concentrate all relevant research and development efforts undertaken by its Members and the related financing.

The SESAR Programme develops its solutions according to a set of essential operational changes for the ATM industry, as outlined in the European ATM Master Plan 2012 and prioritises based on their performance benefit. The current Programme, from 2009 to 2016, is implemented by around 3000 experts working on more than 300 projects to deliver a solid stream of technological and operational solutions, some of them already available to enter the industrialisation phase in view of their deployment.

As a performance-based R&D programme, SESAR systematically validates the maturity readiness of the work of its projects, through a mechanism known as the Release process. Since 2011, SESAR has been carrying out one release every year and has so far completed 68 exercises, establishing the solutions' readiness for industrialisation and subsequent deployment.

As it was agreed at its launch, the current Programme focuses on delivering technological and operational solutions answering to the European ATM Master Plan.

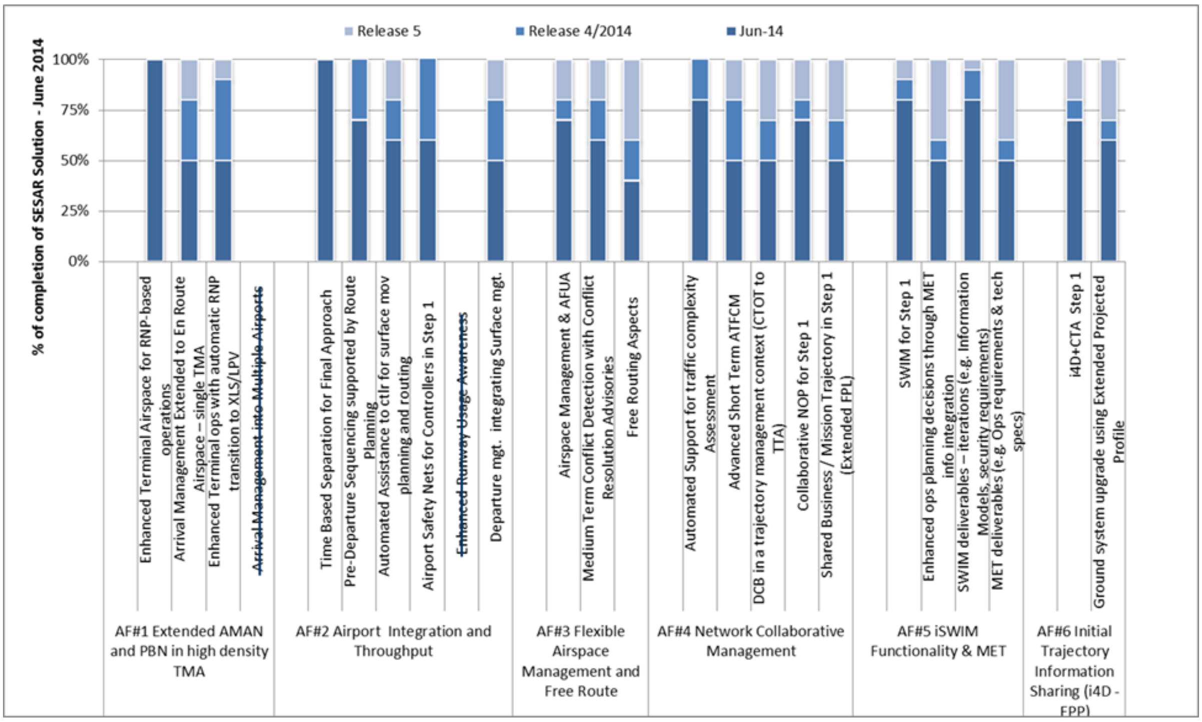
The output of the SESAR Programme is clearly identified through the notion of SESAR solutions (further defined in section 3.4.1).

The SESAR Solutions are grouped into:

- Moving from Airspace to 4D Trajectory Management
- Traffic Synchronisation
- Network Collaborative Management and Dynamic Capacity Balancing
- Airport Integration and throughput
- System Wide Information Management
- Conflict Management and automation

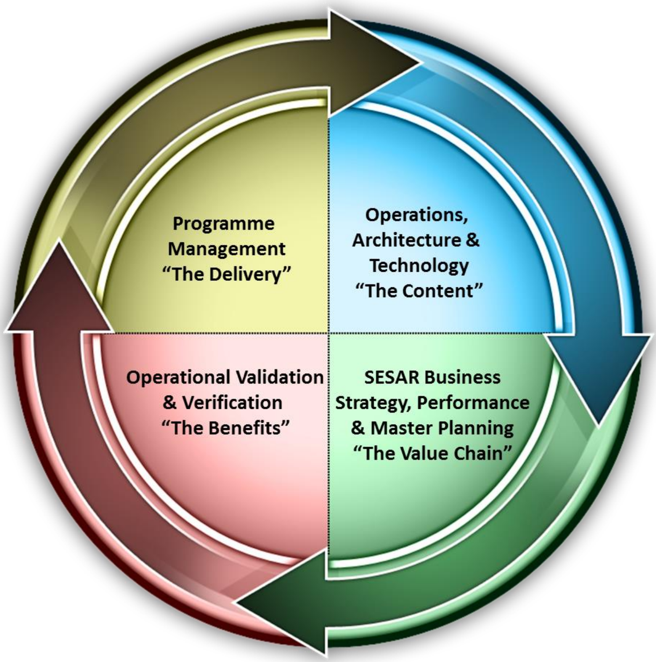
Details can be found on the SJU website at www.sesarju.eu/solutions.

A number of those solutions have been grouped in ATM Functionalities and form the technical basis of the Pilot Common Project (PCP). Further Solutions which may be packaged in future Common Projects will result from the validation activities to be performed each year from 2014 till 2016. In terms of contribution to the PCP the current outlook is shown below:



The Programme 2020 will need to maintain a wide Public-Private Partnership with industry and stakeholders taking a strong commitment to continue delivering results. In addition, scientific areas of research excellence will be further developed with the Universities and Research Centres playing a strong role in research along with innovative SME organisations. Together with Industry these organisations shall establish early applications and assess the potential for benefits to ATM.

The scope of the Programme will address four dimensions, from Programme Management and Delivery through Content, the Value Chain and Benefit realisation.



In a similar manner to today, the Programme shall engage the breadth of the whole stakeholder community with airspace users, military, professional staff associations etc. being fully involved in the work being undertaken and the relevant decision making processes.

In accordance with agreed key principles it is planned that Programme 2020, set from 2014 and operating in accordance with the financial perspective and the SJU regulation; cannot be fixed once at the outset. Consequently provisions shall be made for transition of work in progress from the existing programme as well as adequate assessments against the on-going performance and business needs developments of the stakeholders. This will be designed to allow promising results from exploratory research to evolve into applied research, development and preparation for deployment during the life of the Programme, thus accommodating an evolution of the topics to achieve the SES and reducing time to market for the most beneficial ideas.

1.1.3 Role of the SJU

During the first programme, the SJU has established a formal Administration, Programme Management, Operations Management and Technical Competence to meet its obligations as established in the Council Regulation basic act as well as towards the ATM community and, finally, each citizen and tax payer.

The SJU will foster added value, performing with the utmost professionalism and commitment with its current and future Members the work described in the SESAR Programme 2020, in particular:

- In maintenance and execution of the European ATM master Plan, as defined in the SJU Regulation, to ensure the planning which, inter alia, bridges R&I with deployment and the necessary feedback;
- Maintaining the established sound financial management and focus on delivering deployable results;
- Ensuring appropriate efforts are applied into Exploratory Research to keep innovative ideas flowing in and allow promising results from Exploratory Research to evolve in Applied Research, Development and preparation for deployment;
- Through the partnership, that by its nature pulls together resources from the different actors of the domain allowing for the achievement of coordinated and consistent results oriented towards deployment, fed by exploratory research activities developed through industrial research & validation and onwards into very large scale demonstration;
- Providing assurance of continued support to Single European Sky and its evolution and the pro-active management of the whole research & innovation cycle in the context of the European ATM Master Plan, including preparation for deployment and necessary coordination with EASA;
- Will maintain and further exploit the driving role for timely standardisation and global standard setting (using mechanisms including the SESAR-NEXTGEN MoC) in related ATM relevant areas such as airports (environment, capacity, quality), security (including cyber/network security), RPAS/UAV and focussed on the achievement of global interoperability;
- Will ensure the involvement of the Stakeholders at the most appropriate levels of the governance and programme management, including the participation of the different civil and militaries authorities to anticipate possible issues in the future deployment of R&I results.

As highlighted in Commission communication COM(2014)207, SESAR JU is uniquely placed pave the way towards a gradual and smooth integration of RPAS and to coordinate related R&D activities. To define the R&D activities to be conducted to support the integration of civil RPAS into the European Aviation System, the SJU will undertake an RPAS definition phase on the basis of the strategic R&D plan included in the RPAS Roadmap of June 2013. The results of the definition phase will be included in the ATM Master plan Update.

The SJU Organisation

The SJU organisation has established a Mission/Vision, a set of values and key principles relevant for the next period of operation; actively managing in accordance with these. The Mission/Vision is to support:

Delivering best-in-class, globally interoperable and high-performing Air Transport for Airspace Users and Citizens

Where:

"The SJU partnership has successfully introduced innovations, bringing measurable performance benefits to the worldwide aviation community"

In terms of delivering on the Mission/Vision the SJU has strong core values that include:

Innovation

Making a difference, and adding value

Commitment

Ethics & Integrity

Enabling the realisation of the Mission/Vision and embedding the core values has resulted in the establishment of organisational key principles. These are shown in the diagram below:

The SJU organisation will be structured around these key principles and engage with Members, the stakeholder community and international/global organisations in accordance with them.

Aside from the management of an Industry PPP an important issue for the SJU in managing research at low maturity/readiness is managing the knowledge it produces and facilitating its transition towards higher maturity and, ultimately, implementation to build the research and innovation lifecycle as a 'pipeline' from exploratory research to SESAR solutions ready for deployment. This will be performed under H2020 rules with specific responsibilities delegated by the EU to prepare, manage the evaluation and subsequent research activities, and establish gate management and communication of research results.

As single point of focus for ATM research in Europe and through its deep understanding of the entire SESAR R&I Programme, the SJU is in a unique position to make progress here, capturing and interpreting results at lower maturity levels and facilitating upward transition. By definition, this implies taking a view across several maturity levels so that the process is consistent and connected – it oversees and joins together the division of work and organisations between fundamental and application-oriented work, and indeed goes beyond into industrial applied research. Furthermore the SJU provides support for coordination of European positions led by the European Commission, including content input for global interoperability through ICAO.

1.2 Introducing the SESAR 2020 Programme

In this section the SESAR 2020 Programme is introduced. This is focussed upon the overall picture of the research challenges, the programme key features and transversal activities and showing the means of ensuring the flow of promising ideas from Exploratory Research through to validated and demonstrated output with clear performance contribution as \the R&I lifecycle and previously communicated by the SJU as establishing the 'pipeline to innovation'.

1.2.1 Research Phases & Maturity

Research Phases

The Programme 2020 is structured into three main research phases, beginning with Exploratory Research, then is further expanding within a Public-Private-Partnership to conduct Industrial Research and Validation then culminates in Demonstrating in Large Scale the concepts and technologies in representative environments to firmly establish the performance benefits and risks.

Phase 1: Exploratory Research is further broken down into two areas, the first covering the fundamental science and outreach, while the second investigates the initial applications of this science for ATM. The total funding is €85M, 100% contributed from the Horizon2020 for this phase.

Phase 2: Includes Applied Research, Pre-Industrial Development and Validation. As a whole this phase is referred to as 'Industrial Research and Validation' as it is delivered through the Partnership.

Phase 3: Covers Very Large Scale Demonstrations (VLD) to help fill the gap between development and deployment phases and consists of demonstrating key SESAR concepts and technologies to raise awareness regarding SESAR activities related to ATM performance issues and their results as well as assessing full-scale deployment readiness.

VLDs will focus on concepts that provide significant contribution to performance, are sufficiently mature and require coordination at European/Global level (in particular with regards to air-ground and/or ground-ground integration).

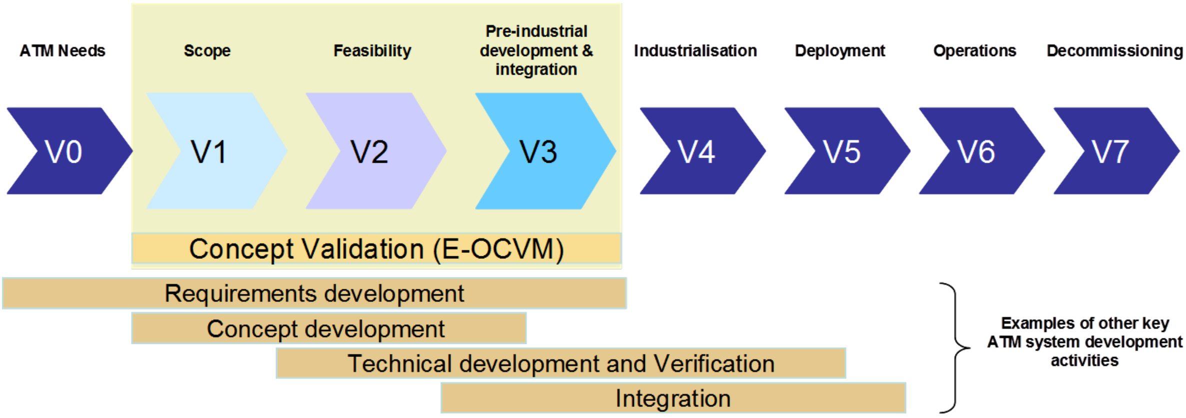
The total funding across Phase 2 and Phase 3 is €500M from the Horizon2020, of the order of €500M from both EUROCONTROL and the industry Members, such that total funding is up to €1.5B.

The three phases above will be further described later in this document.

In addition, there is a need for transversal activities spanning across the phases and including the ATM Design, Performance and the platforms to be used for validating and demonstrating as well as the maintenance of the European ATM Master Plan.

Research Maturity

Regulation 409/2013 calls for the maturity of ATM functionalities to be demonstrated, inter alia, on the basis of the results of validation carried out by the SESAR Joint Undertaking, the status of standardisation and certification processes and an assessment of their interoperability, also in relation to the ICAO Global Air Navigation Plan and relevant ICAO material. Today the SJU has the established principle of managing research maturity using the European Operational Concept Validation Methodology (E-OCVM) and includes gate reviews etc. described in the current Programme Management Plan. Shown in the diagram below (repeated from the official publication) are the maturity phases and the scope of E-OCVM.



While it is expected that E-OCVM will continue to be applied in the Programme in terms of establishing the flow of ideas and results for programme 2020; the SJU is now required to communicate its achievements externally in delivering increased maturity/readiness using Technology Readiness Levels (TRLs). For SESAR, as it is researching and developing systems, technologies and the operations, these TRLs need to be defined in terms of the lowest maturity level for each aspect and not just for the technology. Consequently communication in terms of TRLs will be used in accordance with the following definition. The level of achievement and consequent maturity at each level is described along with the equivalence in E-OCVM maturity phase (V-levels):

<u>Exploratory Research (V0 & V1) covers:</u>

Pre-TRL1 Scientific Research: Fundamental exploratory scientific research investigating relevant scientific subjects and conducting feasibility studies looking for potential application areas in ATM, concentrating both on out-reach to other disciplines as well as educating within.

TRL 1 Basic principles observed and reported: Exploring the transition from scientific research to applied research by bringing together a wide range of stakeholders to investigate the essential characteristics and behaviours of applications, systems and architectures. Descriptive tools are mathematical formulations or algorithms.

TRL 2 Technology concept and/or application formulated: Applied research. Theory and scientific principles are focused on very specific application area(s) to perform the analysis to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.

<u>Industrial Research & Validation (V2 & V3) covers:</u>

TRL 3 Analytical and experimental critical function and/or characteristic proof-of-concept: Proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies including verification of technical feasibility using early prototype implementations that are exercised with representative data.

TRL 4 Component/subsystem validation in laboratory environment: Standalone prototyping implementation and test with integration of technology elements and conducting experiments with full-scale problems or data sets.

TRL 5 System/subsystem/component validation in relevant environment: Thorough testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.

TRL 6 System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space): Prototyping implementations on full-scale realistic problems using partial integration with existing systems. While limited documentation is available, the Engineering feasibility is fully demonstrated in actual system application.

<u>Very Large Scale Demonstration (V3+) covers:</u>

TRL 7 System demonstration in an operational environment (ground, airborne or space): System demonstration in operational environment. System is at or near scale of the operational system, with most functions available for demonstration and test and with EASA proof of concept authorisation if necessary. Well integrated with collateral and ancillary systems, although limited documentation available.

<u>Industrialisation (Beyond SJU) covers:</u>

TRL 8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space): End of system development. Fully integrated with operational hardware and software systems, most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios. Verification, Validation (V&V) and Demonstration completed.

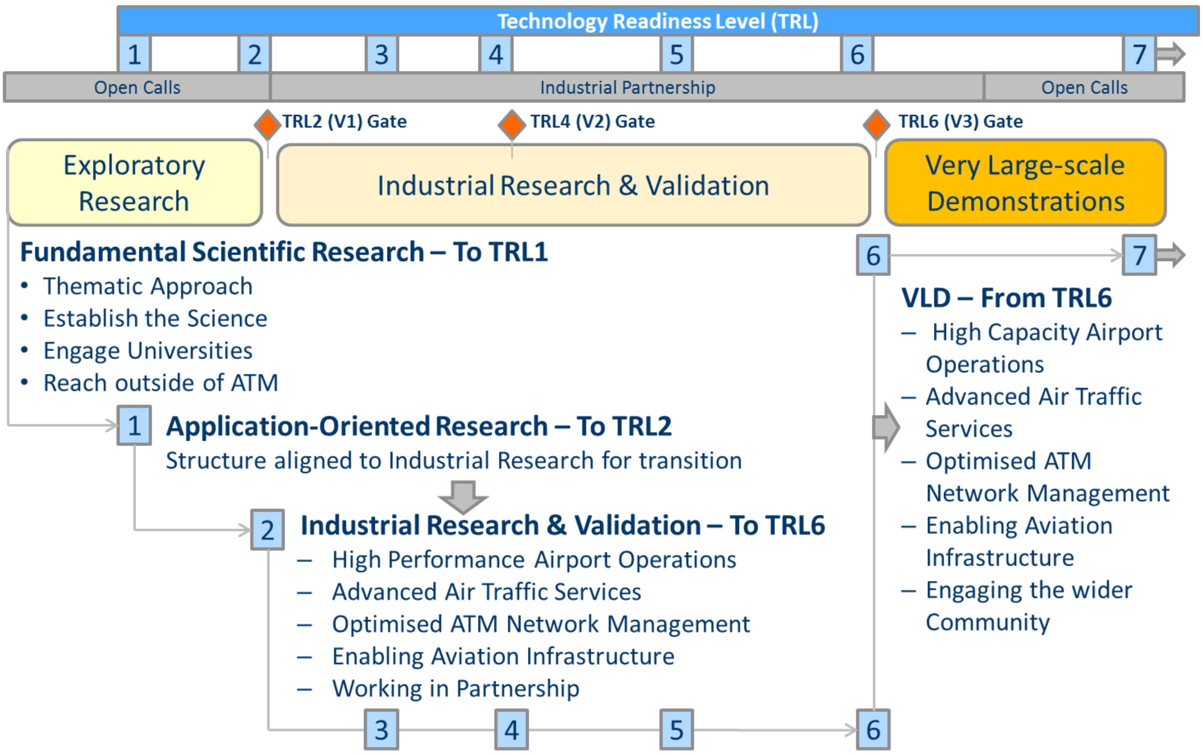
<u>Deployment (Beyond SJU) covers:</u>

TRL 9 Actual system "mission proven" through successful mission operations (ground or space): Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed and successful operational experience with sustaining engineering support in place.

The SESAR Programme 2020 concentrates on the first seven levels and progresses towards TRL8. The SJU will establish gates at transition points between TRLs in order to ensure maturity achieved and results of investment in research can be reported.

Note: The SJU Members individual assessments of TRL status for their own purposes may differ from the SJU communication on overall maturity.

This maturity level is assigned across the research phases and with gates as shown in the diagram below:



1.2.2 Research Challenges & Key Features of the Programme

The research challenges for Programme 2020 build upon the work undertaken in the ongoing Programme and concentrate around the key features and content of the European ATM Master Plan, the stakeholder priorities and bringing the necessary skills and resources together to deliver the right research in an effective way.

This can be represented in the diagram below, where the SJU Mission/Vision is connected to grouped areas of activities focussed around three front-line ATM service areas, supported by the required enabling technologies in the aviation infrastructure as well as exploiting sharing of this infrastructure across all areas to achieve, for example, consistent information management.

As shown in the diagram above and stated earlier, some programme activities need to be undertaken in a transversal manner to ensure the delivery of best in class, globally interoperable and high performing Air Transport for Airspace users & Citizens. For example:

- Master planning to ensure the maintenance of the EU ATM Master Plan and the viability of consequent deployment
- ATM Design and Integration, with a particular focus on the Architecture and service orientation
- Support to Standardisation, Regulation & Interoperability at European & Global level
- Air vehicle Integration, cost and environmental optimisation
- Total system performance management

Another transversal need is to ensure that infrastructure developed to enable operations and services is delivered in such a way that technical services including communication, positioning, navigation, timing and information are shared across the whole community.

Using this overall framework it is intended that Applied Research activities are undertaken, focussing on extending the most promising Exploratory Research. In this phase, there are clearer expectations and quality/performance metrics applied to the work being performed appropriate to the maturity level of the phase. The participants in this phase are targeting an output that can transfer results into pre-industrial developments.

Once the Applied Research activities reach a sufficient level of maturity the Pre-industrial Development phase can begin leading to the delivery of fully validated Air Transport improvement.

Upon successful completion of pre-industrial development Validation activities, larger scale demonstration activities can be performed as required to de-risk transition to Industrialisation & Deployment.

1.2.3 Exploratory Research (Science to TRL2)

Context

The SESAR scope includes projects extending from exploratory research right through to very large scale demonstrations. SESAR Programme 2020 Exploratory Research will build upon the results developed in the previous programme under WP-E (forty projects, three networks etc.) as well as from FP7 funded projects, where relevant. These results shall, where there is evident benefit, be further developed under the scope of the HORIZON2020 Framework Programme in SESAR Programme 2020.

While investment costs were borne by EUROCONTROL for WPE, it has been determined the EU will bear the total ATM Exploratory Research costs under HORIZON2020. The EU has decided that in order to guarantee sound governance and independence of exploratory research, the investment will be entirely managed by the SESAR JU. Private partners contribute neither to its financing nor to its governance.

The SESAR Exploratory Research programme will ensure coherence and avoid overlap with other European research initiatives, such as HORIZON2020 calls and Clean Sky. The SESAR JU will be responsible for the:

- The preparation and publication of the research actions in line with H2020 rules , including procurement action as necessary;
- The management of the evaluation of the proposal in line with H2020 evaluation process;
- The management of the research actions. This will include progress meetings with SESAR JU experts to guarantee the alignment with SESAR programme needs;
- Development of a gate process (involving SJU Members) to ensure that at the end of each project assessment on the maturity reached is performed and therefore decision can be made on the project continuation in higher maturity levels of the SESAR research lifecycle;
- Development of detailed (beyond the definition in section 1.2.1) maturity level criteria for the assessment of the research projects to address low maturity/readiness;
- Capture, review and promote classification and evaluation of research results to feed the R&I lifecycle from a team composed of SESAR ER project manager and SESAR applied research project managers;
- Development of processes that encourage the flow of ideas up through the innovation lifecycle between the exploratory research programme and the applied research programme;
- Inclusion and maintenance of valuable information (e.g. project conclusions and recommendations for future research activities) on the SESAR repository facilities which are user-friendly and provide evident benefit to the research community thus encouraging regular use.

Introduction

This sub-section describes the ER 2020 vision, objectives, context, calls processes, criteria for topics selection and maturity levels. Later in the document there is a high level introduction of research topics that will be further developed into open calls in line with HORIZON2020 rules for participation.

SESAR Exploratory Research drives the development and evaluation of innovative or unconventional ideas, concepts, methods and technologies; that can define and deliver the performance required for the next generation of European ATM system, and thus contribute to its successful evolution.

It addresses areas that analyse long-term research concept/ technology gaps and responds to the European ATM challenges in the evolution of a safe, competitive and sustainable future ATM system.

The Exploratory Research 2020 primary mission objectives are consequently the following;

- To contribute to the European ATM Master Plan towards long term objectives beyond 2035 (i.e. including the 2050 timescale used by Flightpath2050)
- To contribute to the identification of innovative solutions not yet identified in the EU ATM Master Plan but which would accelerate the realisation of the SES targets
- The delivery of sustainable healthy research activities across a range of research organisations and networks in Europe, within the domain of exploratory research.

The key principles that apply to ER2020 are:

- To build upon the successful ATM European research activities beyond SESAR industrial programme (e.g. WPE and FP7)
- To consider innovations/technologies coming from non-ATM sectors such as automation, robotics or system engineering areas as well as safety critical industries, such as nuclear, space, ICT.
- To bring scientific, technology innovation and educational benefits to the ATM Community, in particular industry
- To enable Universities, Research centres and SMEs to undertake research activities that go beyond the main SESAR industrial programme
- To create a healthy body of European ATM, related CNS research capability and knowledge that will strengthen European competitiveness and workforce.
- To create a mechanism in order to monitor and assess the maturity of exploratory research results and their integration into SESAR mainstream and future SESAR 2020 program as appropriate

SESAR Exploratory Research activities will contribute the ATM aspects of the Horizon2020 Transport Challenge “Smart, green and integrated transport”. The objective of this is to achieve a “European transport system that is resource-efficient, climate- and environmentally friendly, safe and seamless for the benefit of all citizens, the economy and society”. As such this programme proposes research topics in the context of ATM that will address the R&I needs below:

- Resource-efficient transport that respects the environment
- Better mobility, less congestion, more safety and security
- Global leadership for European transport industry
- Socio-economic and behavioural research and forward looking activities for policy making

The results of Exploratory Research feed not only the EU Master Plan but set the scope of later updates to the content of Industrial Research and validation. In addition the results of the work have value within the Scientific Community and support the development of improved skills, reputation and research capacity.

1.2.4 Industrial Research & Validation (From TRL2-6)

The R&I activities of the SESAR Programme 2020 are designed to encourage the migration of ideas from Exploratory Research and have them further extended in the Applied Research phase and finally to pre-industrial development, validation, large scale demonstration and then final preparation for deployment.

Applied Research and Pre-Industrial Development both are undertaken against a common structured framework to help develop key topics relevant for Air Transport evolution, enable transition from Exploratory Research to Applied Research as well migration from Applied Research to Pre-Industrial Development. This common framework must also support the need to focus on an integrated product, its validation and very large scale demonstration as well as feedback from this to influence the needs of further research.

This framework relies on:

- The SESAR Concept Storyboard
- The SESAR reference Architecture and Technical System Strategy
- SESAR Programme Lifecycle

The goal of the SESAR "Concept Storyboard" is to ensure that the SESAR 2020 concept is developed in a simple and implementable manner. The concept has been structured in three operational steps, which correspond to manageable, implementable and valuable collections of operational improvements that the ATM community can articulate and identify with. This introduces an incremental approach to concept development, validation and deployment, improving the likelihood of successful implementation.

The SESAR reference Architecture and Technical System Strategy defines the principles for the future ATM single European architecture, in support of setting a vision for ATM stakeholder decision makers and providing guidance for projects on system design and architectural (structure) issues. Similar to the Concept Storyboard it foresees three so called "to-be" architectures that represent the target evolution of the European ATM system over time. Following the SESAR Architecture and Technical System Strategy, the various architecting activities within the SESAR Programme are consolidated and made consistent in the European ATM Architecture (EATMA).

SJU foreground documentation covering, but not limited to, operating concepts and various documents supporting standards development will be made available to external entities. In particular this will include information exchange with the Clean Sky JU and its work programme.

All the activities for the production of the deliverables and their grouping into SESAR solutions follow a defined lifecycle: the SESAR Programme Lifecycle represents a sequence of major events enabling the research and development of proposed SESAR Solutions from their initial definition to their confirmed readiness for further industrialisation and deployment. In particular, it is noted that as the SESAR Programme is driven by the Performance Framework, Business Case feasibility and maintains a Deployment focus, such overarching and transversal activities are being conducted on a continuously iterative basis throughout the SESAR Programme Lifecycle and feedback from Deployment is desirable to help ensure ongoing robustness.

Regulation 409/2013 calls for the maturity of ATM functionalities to be demonstrated, inter alia, on the basis of the results of validation carried out by the SESAR Joint Undertaking, the status of standardisation and certification processes and an assessment of their interoperability, also in relation to the ICAO Global Air Navigation Plan and relevant ICAO material is particularly relevant during the Industrial Research and validation phase and the SJU has established specific coordination links including the Members to the various organisations.

The overview of key steps of the SESAR Programme lifecycle is outlined in the Section 3.3

1.2.5 Very Large Scale Demonstration (From TRL6-7+)

Very Large Scale Demonstrations are designed to help fill the gap between development and deployment phases and to:

- Generate further confidence to support buy-in from main stakeholders including regulators for future deployments.
- Significantly reduce the business risks for both operational stakeholders and industry, in particular for changes included in the Common Projects.
- Provide further inputs to related standardisation activities.
- Raise awareness regarding SESAR activities related to ATM performance issues and their results.
- Accompany SESAR pioneers all the way to pre-deployment.
- To assess full-scale deployment readiness.

They are at the boundary in terms of maturity transition from the Industrial Research & Validation and the Industrialisation / deployment.

Consequently:

- VLDs are there to bridge R&D and deployment, and not to replace either type of activity, with priority given to activities that support Common Projects and the stakeholders making a significant step towards deployment.
- VLDs are a step beyond V3 validation by using end-user systems. They encompass an agreement on the necessary standardisation and regulatory frameworks and allow earlier authorities and EASA involvement (Airworthiness/OPS/ATM) in the overall certification of end to end ATM operations,
- VLDs should help the synchronisation between ground and air deployments (demonstrations in real environments). Ground and Airborne functions should be integrated in operational platforms representative of future environments,
- VLDs need to go beyond SESAR partners and engage a critical mass of airspace users,
- VLDs need to address the most constraining factors ("if it works in the VLD, it should everywhere else").

At the point in time and maturity when Very Large Scale Demonstrations are being considered there is a need for prioritisation and not every SESAR solution will be targeted by a VLD. VLDs need to be confirmed on a case-by-case basis along the following deployment oriented criteria:

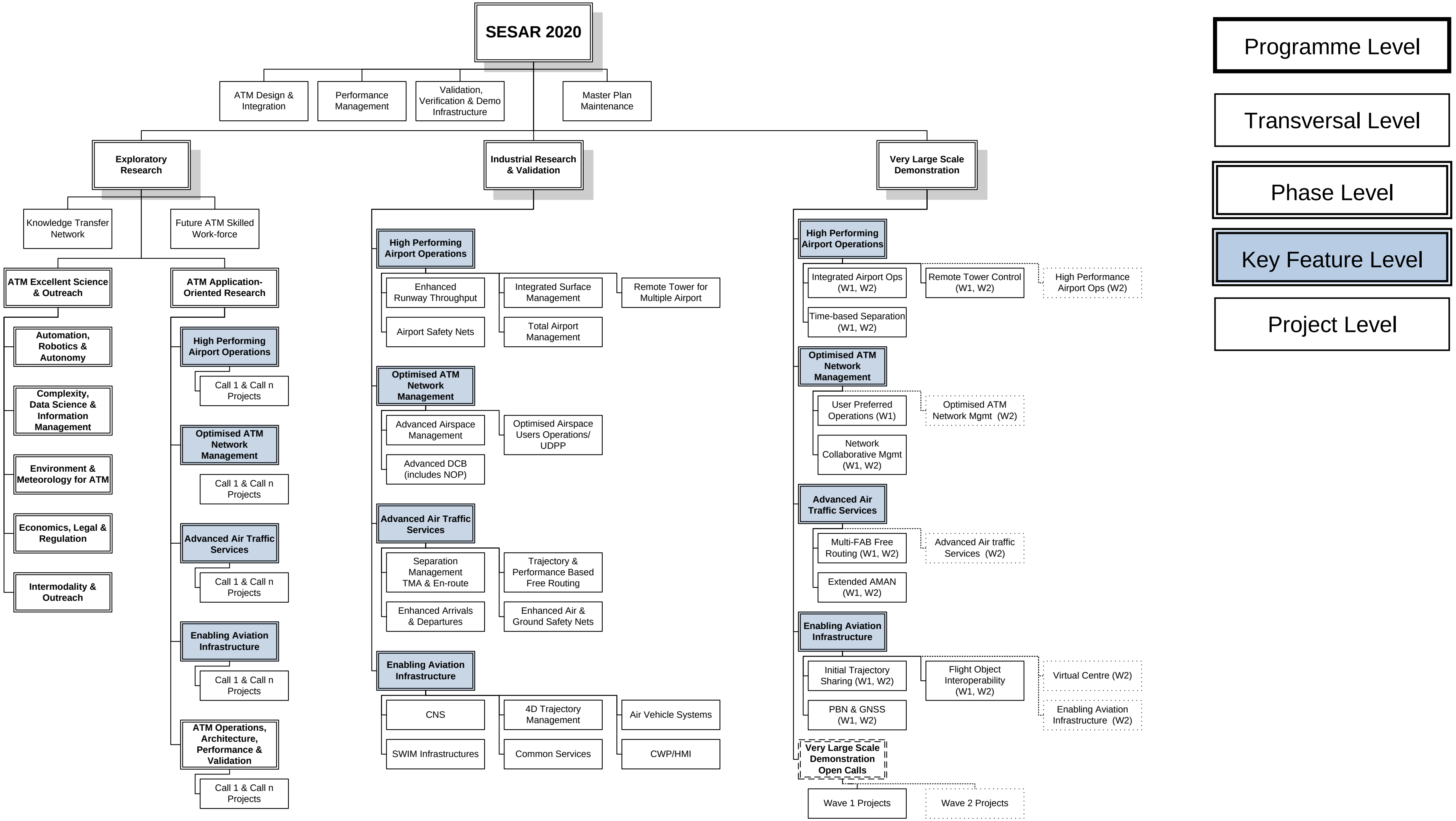
- Significant contribution to performance
- Maturity,
- Need for coordination at European/Global level (with priority given to integration from the air-ground and ground-ground perspectives)

When undertaking VLD activities there will be a possibility to add contributions from beyond the SESAR Members and their respective developments. For example this can include additional facilities, a greater geographic spread, the engagement of various air space users and/or Military as well as conducting VLDs with black-box technologies developed and provided through external programmes including Clean Sky.

2 SESAR Programme – Scope

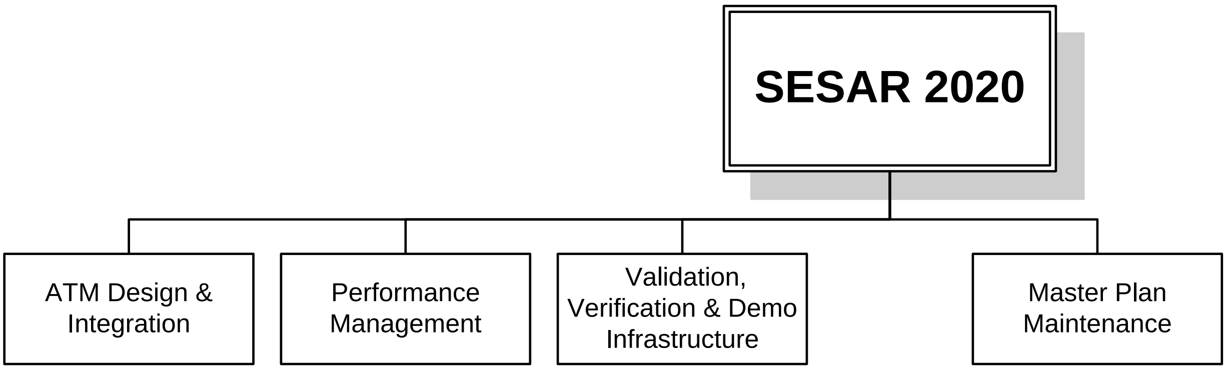
2.1 Structuring the Programme

Using the agreed principles, research challenges and key features for the programme a Work Breakdown Structure (WBS) for SESAR Programme 2020 was developed. It includes Transversal activities and the three phases of research presented earlier. To ensure the flow of research results from Exploratory Research through to Very Large Scale Demonstrations and consistent structure of key features has been applied. The following sections describe each area of the programme down to project level (shown on the WBS).



2.2 ATM Design & Master Planning (Transversal)

In order to provide for coordination and guidance to the whole programme, receive proposals from Exploratory Research results and provide an integration role across phases and key features a number of transversal activities are foreseen. These are pictured below and further described in the following sections.



The transversal activities are key to concentrating and coordinating the delivery of successful R&I results to the SJU stakeholders and are subject to a strong SJU leadership.

2.2.1 ATM Design & Integration

SESAR 2020 will develop and maintain the single reference architecture (one coherent structure) for the European ATM system, including the transition steps to evolve from the baseline towards the target using an open definition methodology (NATO Architecture Framework – NAF).

A successful approach in SESAR 2020 necessitates those solutions developed by the programme:

- are coherent and consistent;
- fit into the architecture framework and contribute to the overall performance targets and the associated concept;
- have links to ensure elements of the architecture are interoperable at a European and Global level as appropriate;
- are visible and their dependencies are clearly identified and managed;
- support programme management decisions and ATM Stakeholder decisions for investment and deployment;
- fit into the global ATM developments;
- are commonly developed to ensure their acceptance by all stakeholders.

While the various R&D projects of SESAR 2020 will develop and validate SESAR solutions, the role of this project is to facilitate, coordinate and consolidate these operational and technical solutions, to ensure their consistency and coherency from a holistic perspective of the overall concept and technical architecture.

In planning and executing the transition steps of the evolving reference architecture baseline it is essential to have good feedback from Deployment activities to help ensure the architecture is 'locked into reality'. This will help steer the next evolution steps towards maximising the delivery of tangible and required ATM benefits & performance for stakeholders.

2.2.2 Performance Management

The project will maintain, support and ensure the application of the performance framework to be applied by the SESAR 2020 projects (described more fully in the respective Definition of Work in Appendix B). It will provide specific reference and guidance for Safety, Security, Human Performance, Environment and CBAs (among others. This will ensure harmonised performance assessment for all SESAR performance Areas to be executed by projects associated with each key feature. The Performance Management project will aggregate the performance results in order to compare them with the SESAR performance targets and to perform a gap analysis that would lead to recommending new activities or concept changes to fill identified gaps. Finally, it will provide as well coherent performance management support to Very Large scale Demonstrations (VLD) and Exploratory Research ATM-oriented Research projects.

2.2.3 Validation, Verification & Very Large Scale Demonstration Infrastructure

The opportunity for the SESAR Programme is to move forward, building harmonized Validation platforms and infrastructures with common tools making effective use of valuable engineering resources to produce standardised results across a range of IBP infrastructures, obtaining a valuable asset for European Research & Development. Therefore, the methodologies (defined in SESAR 1) to develop V&V Infrastructures (Integrated Based Platforms, Real Time Simulation, etc.) will be applied by the SESAR solution and VLD projects. The maintenance and improvements of these methodologies will be under the responsibility of this project. The industrial development of the validation and very large scale demonstration platforms, with particular respect to the IBPs is excluded from this project and is under the responsibility of each SESAR Solutions and VLD project (e.g. the production of prototypes, industrial tools/mock-ups, IBP engineering artefacts, system integration for VLD)

2.2.4 Master Plan Maintenance

Within the Single European Sky (SES) initiative, the European ATM Master Plan is the agreed roadmap driving the modernisation of the Air Traffic Management system and connecting SESAR R&I with deployment. It is the key tool for SESAR, providing the basis for timely, coordinated and efficient R&I and deployment of new technologies and procedures.

The maintenance and execution of the European ATM Master Plan, as defined in the SJU Regulation, are consequently at the heart of the SJU activities. Selected results of Exploratory Research topics that offer the potential for contribution to ATM performance benefits supported by stakeholders will contribute to the ongoing evolution of the ATM Master Plan and in particular prolonging its scope and targets.

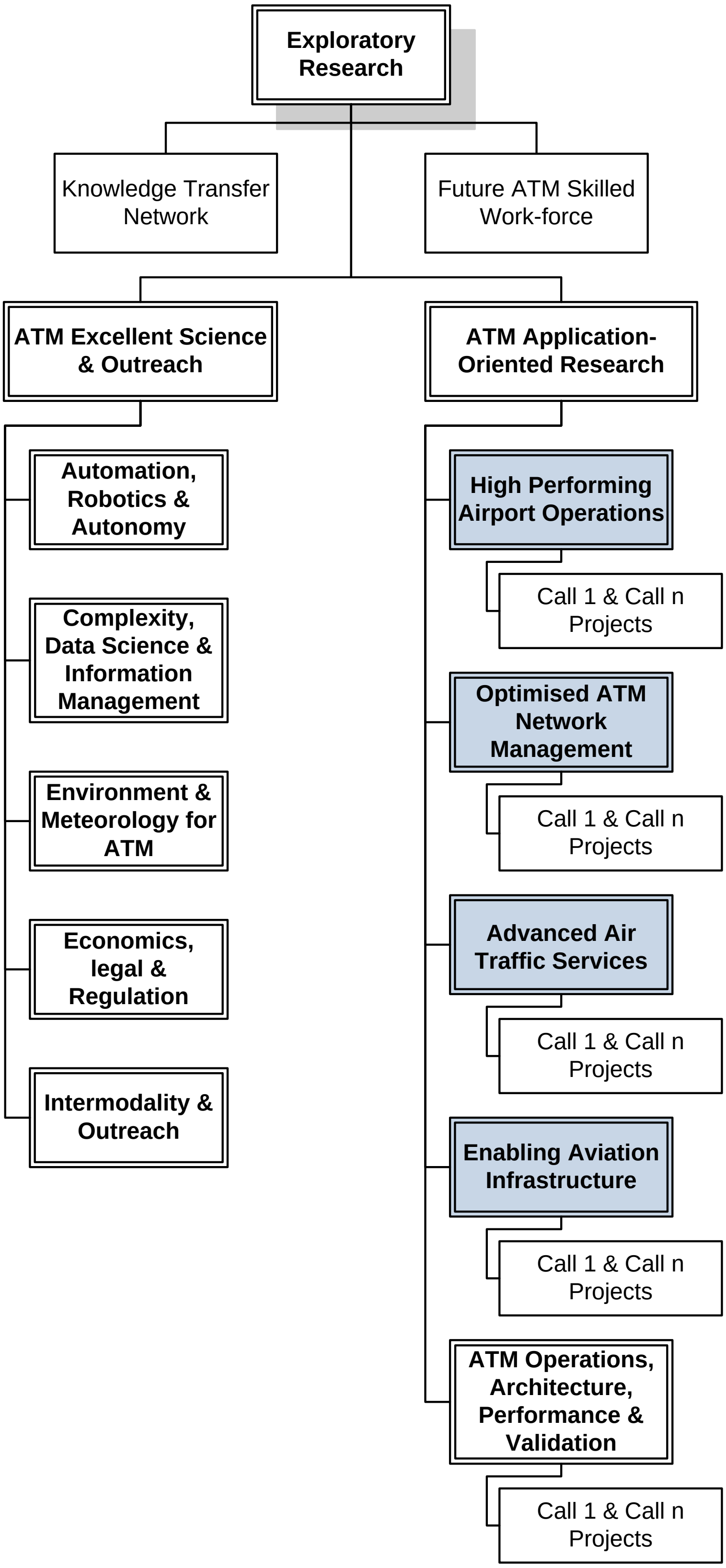
The main scope of the Master Plan Maintenance project is to administrate the up-to-date maintenance of the European ATM Master Plan. It also maintains the standardisation and regulatory roadmaps in order to contribute to getting the right standards at the right time to support deployment. This includes ensuring the ATM performance needs and expectations are correctly established at the highest level and can flow into the programme to drive R&I prioritisation. This means there must be a close collaboration, in particular, with the Performance Management project.

This project will provide advice to the EC on regulation requirements and timing, including any linkage to standardisation. The update(s) to the Master Plan will also incorporate the results of the civil RPAS definition phase. It will identify the specific R&D activities to be conducted as well as any civil RPAS dimension to be introduced in other R&D/Deployment activities.

With particular regard to the Master Plan Maintenance, the arrival on the deployment scene of the Deployment Manager will bring the SJU to reconsider the current set up for the maintenance activities, with particular regard to the level 3 of the Master Plan. While the overall responsibility of the Master Plan is assigned to the SJU there will be a need for a very strong coordination with the Deployment Manager.

2.3 Exploratory Research (Science to TRL2)

Taking due account of the research needs from the assessment and the consultation process, the exploratory research within SESAR 2020 will be organized around four areas: two research areas and two transversal areas, as presented in the figure below:



Exploratory Research is outside of the SESAR Public-Private-Partnership and fulfilled by open calls using various instruments available within the Horizon2020 rules. This version of the work breakdown structure and content specification will be used as the basis for the future Exploratory Research call specifications.

2.3.1 Transversal Activities

Future ATM Skilled Workforce

The Transversal area Future European ATM skilled force area will develop the mechanism to provide the required European ATM education & training as well as networking capability which can uniquely be created through SESAR and in the ATM Community.

Knowledge Transfer Network (KTN)

The knowledge transfer network will be responsible for assessment, coordination and communication of the exploratory research results as well as being responsible for supporting the organization of the SESAR Innovation Days.

The assessment and coordination of project results though a virtual KTN will contribute to identification of innovative ideas, concepts and models that can support the identification of ATM system concept trade-offs new technology validation at system level and requirements definition and consolidation. The ATM research community will be able to share research results.

2.3.2 ATM Excellent Science & Outreach

ATM Excellent Science & Outreach aims to bridge ATM research with the wider research community and will provide the science necessary to support ATM change either directly or through connection to other funded research areas in other disciplines or sectors. Outreach is twofold, first in ensuring its optimised integration in the future multimodal transport system and second in building on research activities in other sectors and industries.

The research performed under ATM Excellent Science & Outreach it is typically curiosity - driven and explores unknown research areas. This type of scientific research not only brings new knowledge, but also encourages young scientists to develop innovative ideas, concepts and theories for the future ATM evolution. This will bring mutual benefits to SESAR research activities and to the HORIZON2020 transport work programme in particular.

Consequently, the purpose of this research area is twofold:

- to investigate through research and innovation actions which new technologies, methodologies, concepts, or validation methods developed in non ATM sector could be introduced in the context of ATM and in particular serve the identified SESAR business needs and Flight path 2050 vision, or identify new ATM business opportunities;
- to assess the potential of ATM related technologies, processes, systems, environment, network architecture and management developed in the context of SESAR in particular to respond to other transport mode challenges.

In this area R&I actions would require the participation of ATM and non ATM experts. The projects will have a recommended duration of 18 months and a maximum duration of 24 months, except for some academic oriented projects which could have a maximum duration of 3 years. Furthermore these academic oriented specific actions will have to be conducted in coordination with non-academic bodies directly involved in ATM and preferably in SESAR or other ATM programmes (e.g. NEXT-GEN).

Procurement actions may be used to support the research projects e.g. for data preparation, modelling, scenario design, extension of a specific area of project, acquisition of specific modelling tools etc.

Automation, Robotics & Autonomy

The research activities under this theme will focus on automation with robotics being explored in terms of the application of higher levels of automation to the ATM system, including its vehicles (civil RPAS and automated modes of operation) and airports. This will include researching whether and in what ways autonomy could be used to deliver operational benefits.

Automation could provide the key to significant performance improvements across many aspects of ATM. ATM today relies on high levels of human intervention for essential functions - in this respect it lags many other industries. Uptake of automation has been slow partly because the positive benefits of human cognitive abilities, especially in safety-critical situations, have provided strong arguments against change. This dilemma has not been addressed to the satisfaction of the community.

The challenge is therefore to propose automation solutions that have the capability to provide substantial and verifiable performance benefits whilst fully addressing safety concerns.

As higher levels of Automation will result in increased importance of robotics, which deals with the design, construction and operation of highly automated systems, an ‘unconstrained’ approach should allow for a bolder vision and subsequently open the door for new conceptual possibilities.

Under this topic there is substantial scope for learning from other industries. From other transportation modes, for example metro systems have benefited from advanced automation with an emphasis on safety and a clearly defined role for human operators.

Complexity, Data Science & Information Management

The research activities under this theme will address complexity science, data science and information management (including AIM) and their applications in ATM. Complexity science will deal with the application of complexity theory in the ATM domain and will therefore contribute to a better understand how the ATM system works, in particular the interaction of its subsystems.

Data science is an emerging field of research in ATM concerned with managing and exploiting large data sets and its application to air traffic management. This will enable further exploitation of information management, knowledge creation and improved insight into optimising planning and execution of ATM.

Environment & Meteorology for ATM

The objective of the research activities under this theme is to benefit from the research activities and investments in these areas from outside of ATM and selectively apply them across the environment and meteorology domains in the context of the future ATM system and its evolution. In addition selective limited investment in potential applications across will be made to understand how these subjects can be applied across the structure of SESAR Exploratory ‘application-oriented’ Research.

Economics, Legal & Regulation

In recent years the importance of understanding the evolution of the ATM industry market structure, the need to minimise airborne costs, use of cost-effective new business and pricing models has become evident. The research performed under this programme will contribute to the innovation and competitiveness of the European ATM industry, therefore contributing to Challenge 2 of FlightPath 2050 to the competitiveness of the European aviation industry. The competitiveness of the European ATM industry will be linked also to the importance of accessing new export growing markets and the importance of products and services competitiveness and capabilities for new market targeting and positioning.

The links between economics, the legal and the regulatory frameworks and the research performed in each subject are close; meaning that implications of change in one area have to understood across the whole otherwise change in ATM can be unnecessarily blocked if there is insufficient understanding in this area. For example, to establish benefits and risks of different ATM business models it is useful to include lessons learnt from other industries.

Intermodality & Outreach

The research activities under this theme will address the connection and dependence between ATM/Aviation and other transport modes, from the perspective of ATM. Consequently, complementary research will be performed to activities launched by the EC in other transport areas (i.e. rail, road, water) to ensure interoperability and delivery of complementary services to realise cross-modal performance as well as move towards the EUs Intermodality objectives.

Research into intermodality will clearly need to address the aspect of the influence to/from non-ATM disciplines (e.g. automotive, rail, industrial automation, etc.). This outreach will provide for the transfer of ATM expertise (e.g. safety, network operations, etc.) in other modes of transport (rail, maritime, etc.) and vice-versa.

2.3.3 ATM Application-Oriented Research

The ATM application-oriented research area will help mature new concepts for ATM beyond those identified in the ATM master plan as well as help mature emerging technologies and methods to the level of maturity required to feed the applied research conducted in the Industrial Research and Validation phase of SESAR; thus connecting the ATM Exploratory Research to the ATM Applied Research in the context of the European ATM Master Plan.

There may be explicit expectations with regard to the composition of consortia that will do the work. For example, some projects may explicitly require the presence of an ANSP, an airline or some other expertise either within or outside the SESAR membership.

Procurement actions may be used to support the research projects e.g. for data preparation, modelling, scenario design, extension of a specific area of project, acquisition of specific modelling tools etc.

High Performing Airport Operations

The research activities under this theme will include research into areas of enhanced runway throughput, integrated surface management, airport safety nets, total airport management and remote tower for multiple airports. As airports remain one of the most significant bottlenecks in ATM and therefore represent great potential for system-wide improvement it can be expected that a significant focus will be placed on realising improvements.

Optimised ATM Network Management

The optimised ATM Network management theme will include research activities in the areas of advanced airspace management, advanced Dynamic Capacity balancing and optimised airspace user operations/UDPP. Innovative solutions are needed to better understand and improve the robustness (resistance to perturbations including meteo perturbations) and resilience (ability to recover) of the network.

Advanced Air traffic Services

The research activities under Advanced Air Traffic Services will include research into enhanced arrivals & departures, separation management, enhanced air & ground safety nets and trajectory and performance based free routing. Separation needs to be resilient in the sense that if one system or agent fails or miscalculates or misses an event, another system or agent in the system will detect and assist. Future research into resilient separation is important. Operational concepts can often be underdeveloped and therefore, the establishment of viable operational sub- concepts or working practices will be beneficial in the context of guiding the future investments, including scenarios for economically interesting equipage update steps in the air, space and/or ground based improvements in ATM.

Enabling Aviation Infrastructure

The provision of flight information (e.g. position, speed, altitude, etc.) for air traffic control from payloads on-board European and national satellites, complementary to ground-based systems. The future reliance on space-based ADS-B and satellite-based information carry risks and opportunities that need to be further researched.

CNS for ATM has a limited level of technology integration- multiple technologies are used where it could be possible to merge into one, both within and across domains, with potential for substantial cost-savings and efficiency gains as well as improvements to security. An overarching study could therefore be the design of an integrated/interoperable/open CNS architecture for the long term (2030+) exploiting synergies, saving cost and optimising spectrum usage. Spectrum is a limited natural resource and increasing spectrum demand is putting aviation under pressure. R&D should move towards spectrum-efficient CNS with a holistic approach addressing the full life cycle of the system including (spectrum-related) technological evolution within the life cycle. The introduction of new technologies may be delayed or hampered due to a strong linkage of applications to certain historical technologies. Therefore, savings in cost and efficiency or improvements in terms of safety may be prevented unintendedly.

Consideration of the use, or adaptation, of new technologies being developed outside ATM to support ATM CNS needs including analysis of the safety, performance and security implications for the ATM system. Technology lead times in ATM along with certification requirements should be taken into account. More flexible system architectures for ground and airborne systems should be considered in this context (e.g. building on integrated modular avionics and an open interface approach to ground system development).

Particular attention will be given to civil RPAS and automation systems in accordance with the RPAS Roadmap of June 2013 to establish the early application of results from the Automation, Robotics and Autonomy Science area into Air vehicle systems and automation for ATM.

ATM operations, Architecture, performance & Validation

The results from the research activities under this topic will directly contribute to the SESAR 2020 transversal activities of ATM Design & Integration, Performance Management, Validation, Verification & Demo infrastructure and Master Plan maintenance.

2.4 Industrial Research & Validation (From TRL2-6)

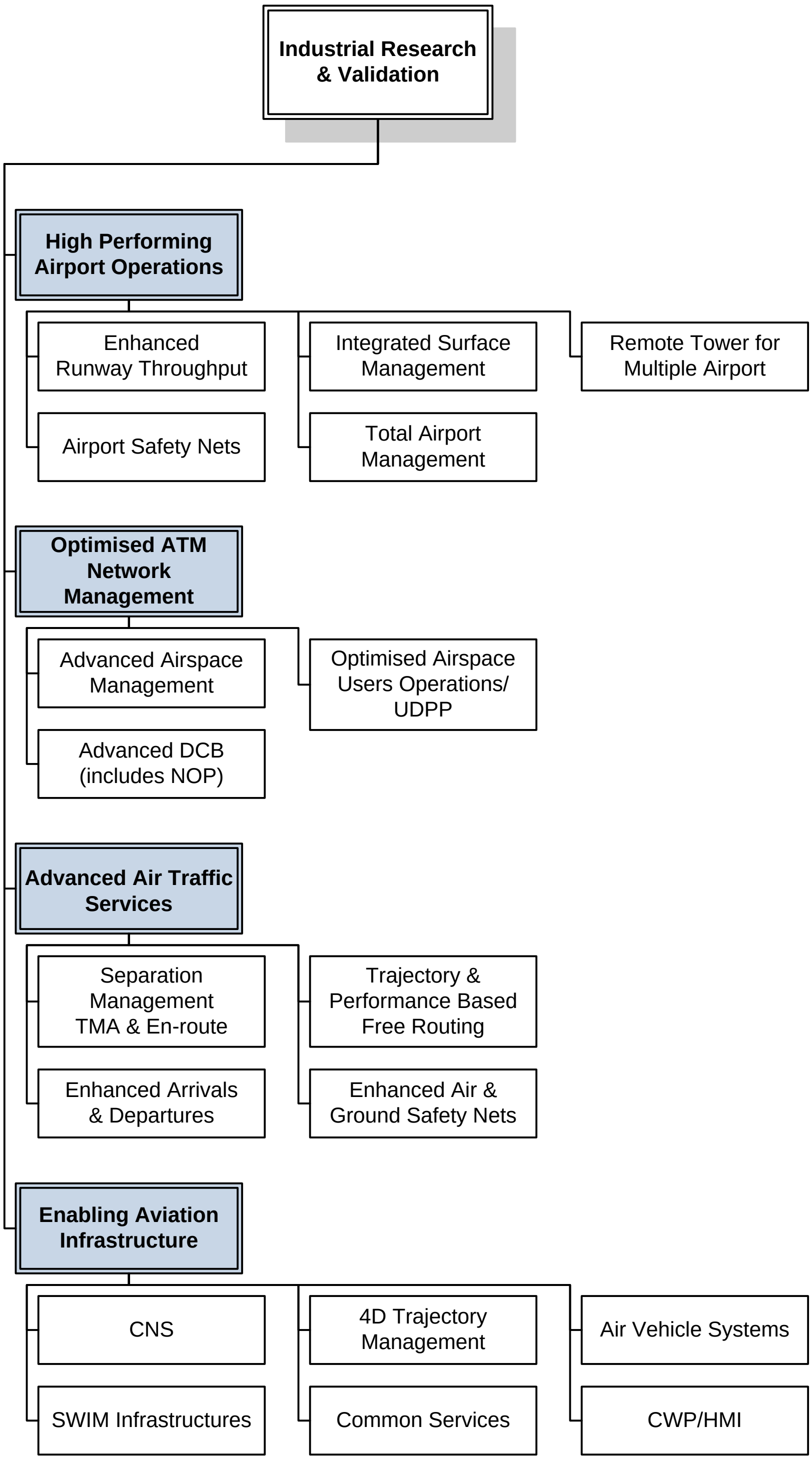
The SESAR Programme will contribute to make the Single European Sky (SES) a timely reality by developing technologies and procedures for a new-generation of the ATM system. The SESAR Programme2020 will continue to engage standardisation and regulatory bodies as well non-Member stakeholders in the work being undertaken.

In terms of structuring the work, four new Key Features have been identified to capture the operational improvements and technical enablers required to answer the needs of the Air Transport evolution and meet the SESAR Performance contribution to the SES Strategic performance Objectives, these are:

- High Performing Airport Operations
- Optimised ATM Network Management
- Advanced Air Traffic Services
- Enabling Aviation Infrastructure

The scope of these 4 key features are decomposed in two waves each targeting specific validation timeframes (2015-2018 for Wave 1 and 2018-2020 for Wave 2). The Wave 1 is therefore focusing on either validation activities that pursue and finalise work already performed in the SESAR 1 Programme, or on the initiation of validation lifecycle for the Wave 2 activities. The Wave 2 will then complete the required validations to deliver the full scope and content of SESAR 2020 Industrial Research Programme.

The Work Breakdown Structure below and the associated projects are described in the following sections. A high level view of the content is provided while further details can be found in the Definitions of Work (DoWs) in Appendix B.



2.4.1 High-Performing Airport Operations

Ensuring high performing operations at European airports will rely on the full integration of airports as nodes into the ATM network, ensuring a seamless process through CDM, in normal and through the further development of collaborative recovery procedures in adverse conditions.

Enhanced Runway Throughput

Maximising the runway throughput and using airport runway configuration to its full potential in all weather conditions will require reconsidering the time-based wake turbulence separation minima. It will allow optimising and dynamically adjusting the aircraft separations between successive aircraft based on actual wake-vortices information. Met considerations must be included in developments and prototypes in support of validation.

In addition, the definition of optimum braking procedures and the development of associated datalink technology and controller support tools may reduce the runway occupancy times. These two elements will both be expected to contribute to increasing runway throughput.

Development of GBAS Cat II/III approach procedures will maintain the airport capacity in low visibility conditions as well as including using curved approaches, increased glide slope etc. for noise abatement.

Integrated Surface Management

The integration of advanced A-SMGCS functions with AMAN/DMAN and Airport CDM will allow improving reliability and predictability of taxi times and capability to manage the revised Reference Business Trajectory (RBT) during taxi phase. It will also allow linking Arrival and Departure times of a specific flight between the different airports concerned providing an overall view of the optimum sequence. The use of flight deck automation system (e.g. optimising speed adjustment) together with engine-off taxi operations will also optimise surface performances in terms of enhancing the trajectory management on the airport surface and reducing fuel consumption and emissions. Efficient taxi operations will also benefit from the development of Enhanced and Synthetic Vision Systems (ESVS) concepts aiming at improving pilots' ability to conduct taxi in low visibility conditions. Furthermore use of Combined Vision Systems (CVS) for final approach could make a positive contribution in the enhancement of runway throughput.

Total Airport Management

Further integration of airside performance monitoring and management processes with landside processes e.g. passengers flows will improve the predictability of the aircraft process. Improving the turnaround monitoring with all actors involved and a more proactive management of weather predictability are other elements that will be required to ensure a total airport management and taking account of dependencies on the SWIM enabling aviation infrastructure.

Airport Safety Nets

Airport safety nets will be further enhanced taking benefit of automation in particular in low visibility conditions. It will cover the enhancement of existing and development of new Airport Safety support tools for pilots, vehicle drivers and controllers to avoid collisions by predicting, detecting and providing alerts for safety critical issues (e.g. risk of collision route deviations, etc.) on the airport surface.

Remote Tower for Multiple Airport

Finally, this key feature will include the cost effective provision of Air Traffic Services (ATS) at several airports at a time from a control facility that is not located in the local ATS Tower. The remote tower operations in contingency solutions will ensure as well that ATS can maintain a high level of capacity in cases when normal tower operations are not available.

2.4.2 Optimised ATM Network Management

Optimised ATM Network Management relies on a dynamic, on-line, collaborative Network Operations Plan (NOP) fully integrated with Airport Operations Plans (AOPs) considering all relevant actors' planning aspects including airports, airspace users, FOC/WOC stakeholders, decision makers, etc. This linking of AOP/NOP parameters (BT/MT and User Preferred Trajectory) optimise the network and airport management by timely and simultaneously updating AOP and NOP via SWIM, providing Network and Airport Managers with a commonly updated, consistent and accurate Plan. The NOP becomes the reference information for all planning and executing actors: Airport Operators, ANSPs, Airspace Users and Network Manager.

Advanced Airspace Management

Automated support for traffic complexity assessment will enable anticipating situations where the traffic complexity in a specific area is out of equilibrium or out of proportion as regards other directly related areas. It will also enable the assessment of impact on airspace capacity, predictability, flexibility and safety. This information will lead to the development of new associated functionalities to asses Dynamic Airspace Management and Resource Allocation measures (e.g. dynamic sector configuration), and Traffic Management measures (e.g. re-routing, level capping) with the final objective of solving complexity problems. This will include the definition and refinement of associated processes, roles, responsibilities, functionalities and information exchanges required to perform Demand Capacity Balancing activities.

Advanced DCB (includes NOP)

Integration of Dynamic Airspace Configuration into the DCB process allows considering demand/capacity needs or constraints when elaborating airspace configuration but also providing capacity imbalance solution through a reconfiguration of the airspace. As part of this airspace configuration management, answering adequately to military airspace users' needs while minimising the impact on the network will be performed through the set-up of different types of temporary Dynamic Mobile Areas (DMA).

Optimised Airspace Users Operations / UDPP

Adequate reaction to ATM disruption is also key to minimising the impact on the Network operations and to ensure as far as possible Airspace users keep their schedule priorities on track. The User Driven Priority Process of SESAR 2020 will provide prioritisation capabilities allowing AUs to proactively prepare mitigation strategies in face of delays as early in the planning phase as well in fine-tuning swapping in the tactical phase. Procedures and systems will be developed for covering arrival, departure prioritisation, at CDM or non CDM airport and integrated with NOP/AOP and DCB processes.

2.4.3 Advanced Air Traffic Services

This area will benefit from an increased automation aiming at substantially reducing controller task load per flight, while meeting safety and environmental SESAR goals (including fuel efficiency), thus contributing to a reduction in ANSP costs. However, human operators will remain at the core of the system (overall system managers) using automated systems with the required degree of integrity and redundancy. It will mainly rely on the design, development and validation of Automated Supporting tools (complementary set of conflict/interaction detection, situation monitoring and resolution tools) using the best available data (e.g. EPP from the a/c, extended flight plan, etc). These tools will assist ATC in aircraft trajectory conformance monitoring and in preventing, detecting and resolving conflicts in En Route and Terminal Area Operations.

New organisation of the controllers' team associated with new responsibilities and tools may enable the conduct of sectorless operations (controller responsible for a limited set of flights within an airspace shared with other controllers).

Enhanced Arrivals & Departures

Improved arrival/departure management and sequence building in en-route and TMA environments will enable to achieve an optimum traffic sequence resulting in significantly less need for ATC tactical intervention, and the optimisation of climbing and descending traffic profiles. As a consequence flights will fly closer to their optimum trajectories bringing benefits across Predictability, Efficiency, Safety, Capacity, and Environment through:

- The use of downlinked on-board 4D trajectory data to enhance the arrival sequence building;
- The integration of information from multiple arrival management systems operating out to extended range into En-Route sectors with local traffic/sector information through the use of SWIM infrastructure;
- The interaction between Traffic Synchronisation and DCB;
- The extension of use of time constraints (e.g. CTAs) to high density environments using datalink exchange;
- The use of ADS-B for new sequencing & merging manoeuvres including lateral manoeuvres and involving more complex geometries in complement to the 4D environment;
- The provision of automated support to departure metering to enable a more consistent and manageable delivery into the En-Route phase of flight and provides assistance tools to coordinate complex interacting traffic flows within the TMA;
- The creation of an end to end optimised profile and ensuring transition between Free Route Airspace and Fixed route airspace. Dynamic terminal airspace accommodates differing traffic and capacity constraints (e.g. dense and complex TMAs ranging to low demand TMAs).
- The provision of new controller tools, airspace structures and enhanced airborne functionalities to facilitate Continuous Descent Operations (CDO) from Top of Descent (ToD) and Cruise Climb Operations (CCO) to Top of Climb (ToC) in high density operations.

Separation Management TMA / En-Route

Separation management both in en-route and TMA will progressively move from Pre-defined 2D/3D Routes, towards User Preferred 2D/3D trajectories and leading to 4D separation. Delegation of separation responsibility from controller to flight crew under specific circumstances will be further studied in particular for oceanic airspace or airspaces with low traffic density. This project will use the services of the enabling aviation infrastructure to support the development and delivery of new operations and tools.

Enhanced Air & Ground Safety Nets

Ground and Airborne Based Safety Nets (and their compatibility) will continue to be adapted through the use of new surveillance means and wide information sharing, fully adapted to SESAR future trajectory management and new separation modes, ensuring their continuous role of last safety layer against the risk of collision (and other hazards). It will cover ACAS and STCA evolutions to cope with new separation modes, including interoperability with ACAS-X.

Trajectory & Performance Based Free Routing

Free Routing corresponds to the ability of the airspace user to plan and re-plan a route according to the user-defined segments within significant blocks of Free Route Airspace (i.e. multiple FIR Areas of Responsibilities or Functional Airspace Blocks - FABs) where airspace reservations are managed in accordance with A-FUA principles. User-defined segments are segments of a great circle connecting any combination of two user-defined or published waypoints, within high & very high-complexity environments.

2.4.4 Enabling Aviation Infrastructure

It is essential to ensure that on-going development of aircraft and ground systems in SESAR Programme 2020 will focus on achieving globally-harmonized standards to ensure the world-wide applicability of these capabilities. Essential to achieving global agreement are definitions of interoperability of information exchange (air-ground and air-air) as well as other air-to-air interactions (e.g. collision avoidance). This will rely on closer working between aircraft systems, flight operations centre systems and military mission management to ensure ATM performance delivery, supporting all types of air-vehicle types and missions and including weather effects, emissions, fuel saving, noise, air quality and contrail formation etc.

This will be realised through the following projects:

CNS (Communication, Navigation and Surveillance)

CNS technologies are an essential underlying technical enabler for many of the operational improvements and new procedures being developed within SESAR. Synergies between Communication, Navigation and Surveillance need to be considered to ensure an integrated air and ground CNS system which responds to the requirements coming from the operational improvements being developed in SESAR. CNS systems and infrastructure for both airborne and ground must take a more business-oriented approach with efficient use of resources delivering the required capability in a cost-effective and spectrum efficient manner.

SWIM Infrastructure

As new services and information exchange will continue to be defined and refined in the timeframe of SESAR2020, it is needed to ensure proper support to those exchanges by SWIM Technical Infrastructure and to support description of new SWIM profile. SESAR2020 will mainly focus on prototyping the ground instantiation of the SWIM "Purple" profile and integrate it with the airborne system. The SWIM Purple profile addresses the SWIM A/G service and data exchanges necessary to support ATM operational improvements that enable better situational awareness and collaborative decision making. In addition, the current airborne system, which addresses initial A/G SWIM advisory services at the end of SESAR 1, will be enhanced to address operational, safety and performance requirements necessary to support more safety-critical services.

Another important topic will be Cyber Security and SWIM management. The SWIM Technical Infrastructure will also have to provide, support and enforce Cyber Security characteristics. It is therefore already foreseen that the SWIM Technical Infrastructure Cyber Security functionalities (some already specified in current SESAR) will need to be fully prototyped and validated while being open to new needs arising from other projects.

4D Trajectory Management

The SESAR Trajectory Management Framework (TMF) specifies the structure needed to achieve the safe and efficient creation, amendment and distribution of the Reference Business/Mission Trajectory (RBT/MT) including the RBT/MT information content & quality, the Actors involved, and the Services associated with trajectory information (e.g. creation, proposed revision and update processes). This project will elaborate coherent design solutions for managing flight information across the System of Systems architecture in close coordination with project in charge of ATM Design and Integration, driven by operational requirements elaborated in the various SESAR solution[1] projects. Support to validations activities performed by SESAR Solution projects will require developing specific prototypes

[1] SESAR Solutions projects refer to the Projects belonging to the 3 Key Features that are the High Performing Airport Operations, the Optimised ATM Network Management and the Advanced Air Traffic Services

for advanced flight information management services, also taking into consideration the SWIM air/ground requirements. This project builds from the initial 4D (i4D) work performed in the previous programme and includes the Network Manager as well as ATC stakeholder contributions.

A critical aspect of the Aircraft System for further development will be the necessary capabilities to support full 4D trajectory management operations. The necessary navigation and FMS capabilities on the aircraft will be required to plan, negotiate and execute 4D trajectories with a high degree of accuracy and certainty.

This project includes the supporting activities for Aeronautical Information Management (AIM) and for Meteorology and as an enabling activity that is coordinated across the SESAR solutions projects.

Common Services

SESAR 2020 aims to delivering services in a harmonised manner. A Common Service is a service bringing significant benefits in cost-effectiveness and harmonisation to consumers that provides a capability in the same form that they would otherwise provide themselves.

The project will undertake the practical verification of the Common Services to verify the proposed high level architecture and requirements. This will be co-ordinated with other projects to include the work in their exercises. It may require the development and integration of mock-ups/prototypes for the service provider and consumer systems as well as those required for communication, such as SWIM and air ground communication. The results will be used to refine the business case for each Common Service thus clearly demonstrating, where achievable, the added value of using the chosen business model for delivery. The definitions of the services will then be expanded to reflect the lessons learnt and to include safety and security assessments

CWP/HMI (Controller Working Position/Human Machine Interface)

One objective will be to define open interfaces for decoupling the Controller Working positions (CWP) from the information and data services provided by ATM Data Service Providers (ADSP). Those interfaces need to be usable through wide area network connections and have to enable the interoperability of different Air Traffic Services Units (ATSU) and different ADSPs being open and using open standards. Furthermore, the interfaces shall allow remote deployment in an information and Data Centre (IDC) as well as the local deployment at ATSU premises (e.g. virtual centre). In order to fulfil the objectives, activities will lead to develop the service model aspects related to these CWP services and the required prototypes, with the aim to verify the use of open interfaces for the workstation.

Air Vehicle Systems

This research and development area includes researching how all airspace users wish to operate their respective vehicles and services, thus developing the systems to ensure the people, procedures, systems, technologies are delivered in such a way that safely permits the most effective and efficient operation and services. It recognises that different vehicles, for example regional aircraft, because their high take-off and landing rates associated to the relatively slower climbing times have a strong impact on the airport traffic management and in general ATM issues. At the same type available space and costs allowed in regional or business aircraft is lower than large airliners thus requiring fully compatible solutions at lower volume and cost.

The emergence of new operations and services in the frame of civil Remotely Piloted Air Systems ("RPAS") also requires more efforts in Europe to develop common regulatory framework and to enhance the coordination of various on-going R&D initiatives. This should lead to integrate all sizes of civil RPAS operations into non-segregated airspace taking into consideration their specific characteristics. To define the R&D activities to be conducted to support the integration of civil RPAS into the European Aviation System, the SJU will undertake an RPAS definition phase on the basis of the strategic R&D plan included in the RPAS Roadmap of June 2013.

2.5 Very Large Scale Demonstration (From TRL6-7+)

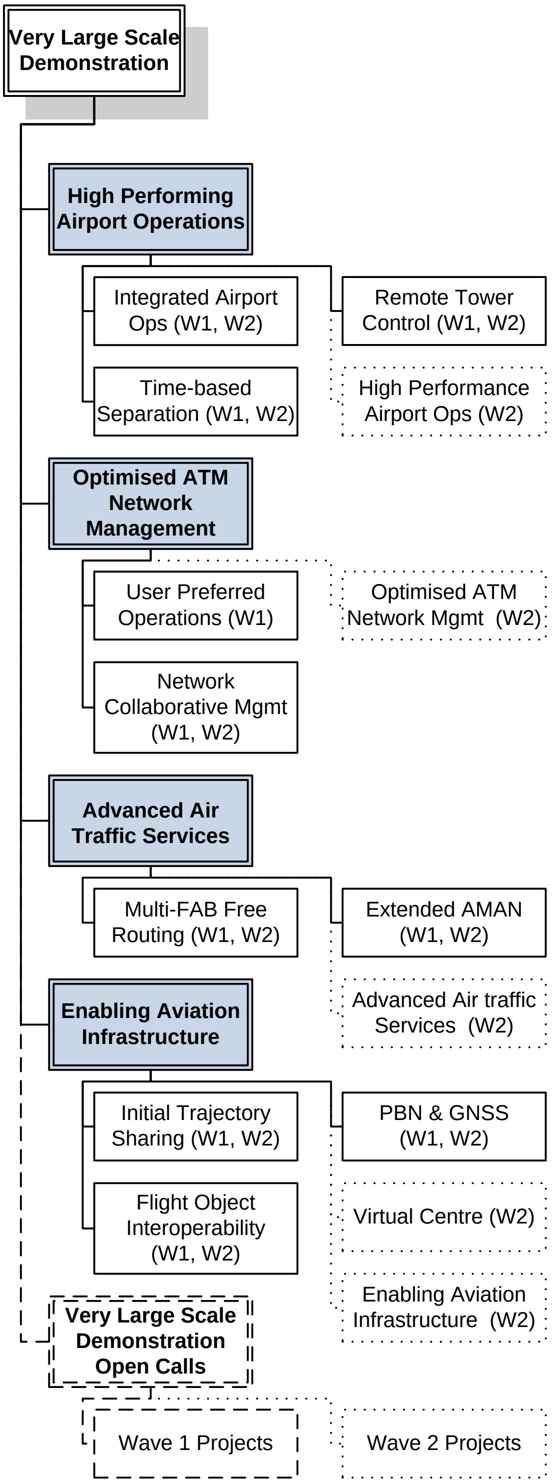
This section presents the content of the Very Large Scale Demonstration (VLD), presenting the related high-level project descriptions.

The key role of VLDs is to bridge the R&I with deployment, and not to replace either type of activity. VLDs are to be a step beyond V3 validation by using early versions of end-user systems (rather than pre-industrial prototypes) and include the integration of new technology elements into existing systems when needed and possible.

As Very Large Scale Demonstrations are designed to help fill the gap between development and deployment phases they are at the boundary in terms of maturity transition from the Industrial Research & Validation and the industrialisation / deployment, they need to have clear links with the Industrial Research activities they demonstrate.

Consequently, VLDs present a clear traceability to the 4 key features of the Programme and are decomposed in two Waves each targeting specific 3 year very large scale demonstration timeframes (2016-2018 for Wave 1 and 2019-2021 for Wave 2). Wave 1 is therefore targeting solutions that are sufficiently mature while setting the content of Wave 2 will be dependent on future deployment orientations and R&D results. Furthermore, in order to reach partners beyond the SESAR Partnership, open calls for tender will be launched by the SJU to further build confidence from the broader stakeholder community on the benefits of SESAR solutions.

The Work Breakdown structure is shown below and these projects are described in the following sections. In this section a high-level preview of the content foreseen for Wave 1 projects is provided. The content of Wave 2 project will be defined on the basis of future deployment orientations and R&D results.



2.5.1 High Performing Airport Operations

Integrated Airport Ops

The aim of this VLD is to demonstrate the integration of Airport (AOP) and Network (NOP) data, surface traffic planning and management and collaborative airport and network processes that deliver arrival and departure predictability for both the airport and the network in nominal and adverse conditions. Activities will cover airport planning and management, including deployment of integrated airport collaborative planning processes, surface routing planning, airport DCB, UDPP and poor-weather activities such as de-icing. Airport safety nets will be included in the surface movement planning, and data-exchange via SWIM, including MET information, will be demonstrated.

The VLD will seek to cover as wide a range of airport types as possible, including both major European airports, with an APOC and full AOP operations, and regional (medium to small) airports, equipped with limited and affordable A-CDM and AOP. Furthermore, the VLD seeks to demonstrate operations at airports that deploy some of the APOC processes in a manual manner.

The airports proposed for separate exercises will reflect different types of operation (hub, regional, point to point), different traffic mix and types (hub carriers, low cost, charter operators, business aviation, helicopter operations), and different capacity constraining elements (gates/stands, manoeuvring area/taxiways, de-icing capability, runway configurations / usage restrictions, noise, TMA).

Separate exercises will be proposed in order to address the different airport operational models, leading to a final exercise comprising a live very large scale demonstration, over an extended time period, collaboratively managing airport performance goals and collaborative processes to show the benefit of the APOC and network linked through AOP/NOP connection.

Time-based Separation

The objective of this project is to demonstrate the application of Time-based separation in strong headwind conditions, which can optimise the arrival flow into capacity-constrained airports, when compared to the current distance-based separation criteria. In future work, the concept may be extended to introduce new pairwise wake-vortex separation standards and more advanced weather-dependent surveillance techniques; this VLD will provide additional analysis and experience to support this evolution.

The VLD will demonstrate the application of TBS at capacity-limited airports in headwind condition, the ability of TBS to support a reduction in wake-vortex spacing between heavy and heavy aircraft within current separation minima, and the ability of TBS to support a reduction in wake-vortex spacing with finals separation minima below 2.5 NMs.

Previous exercises were conducted at London Heathrow and were tailored for that airport's specific needs. This VLD will demonstrate value at additional airports, thus providing confidence that the concept is of more widespread value across Europe, and provide experience and quantitative data to support future developments.

Remote Tower

The aim of this VLD is to demonstrate feasible, cost-efficient and safe operations of multiple remote aerodrome control from single site. The project will demonstrate the capability of a single Remote Tower Centre (RTC) to provide shared Air Traffic Services for a number of airports simultaneously, through traffic coordination, when required by higher traffic demand. The airports will be low to medium traffic density airports, either constantly or at certain periods of time (e.g. seasonably, at specific days of the week, at night, etc.). The remote airports will be provided with the technical systems to support remote control.

Fully operational Remote Tower Modules (RTMs) will be provided within the RTC, with the technical capabilities for serving multiple airports (one-to-one, or one-to-many) to pursue the very large scale demonstration objectives. Reversion between single remote and multiple remote operations will be demonstrated. Different operational scenarios, addressing traffic complexity, weather conditions, low visibility conditions, VFR/IFR flight mix, etc. will be encompassed by the set of very large scale demonstration exercises.

For the purposes of the very large scale demonstration, local ATC services will be maintained fully operational, either to provide hot backup to the RTC, or to allow shadow mode operations from the RTC during trials.

The very large scale demonstration will document safety aspects and take responsibility for coordinating necessary agreements with EASA and National Supervisory Authorities. Furthermore the project will contribute to standardisation activities.

2.5.2 Optimised ATM Network Management

User Preferred Operations

The purpose of User Preferred Operations is to embed trajectory optimisation from airspace user (AU) ground systems into a collaborative ATM environment during all flight phases, including the execution phase, incorporating the business needs from AUs. The goal of this VLD is to share AU trajectory information in high-resolution accuracy based on the architecture and processes to be defined within the SESAR programme's Business/Mission Trajectory, Trajectory Management and 4D architecture study (and aligned globally only as far as required through ATMRPP's FF-ICE, leading to ICAO SARPs), and the information definitions of the FIXM Model and as described in the SESAR ConOps to enable airspace users to plan and fly as close as possible to their user-preferred 4D route.

Network Collaborative Management

The objective of this project is to demonstrate the readiness of the participants to apply advanced DCB procedures involving Network Management functions (NMf) and ATC actors in an interoperable environment closing the gap between the planning and execution phases. It will demonstrate that the process for managing traffic complexity delivers both network and local benefits in the Cost Effectiveness, Fuel Efficiency, Capacity and Safety areas. Through better workload distribution and the reduction of traffic peaks by the implementation of STAM measures, balance between demand and capacity will be ensured.

This project will predominantly focus on measures applied to flights in the pre-departure phase (before the start of the flight execution) and will involve, as a minimum, partners directly involved by the measure (ANSP or Airport initiating the measure, adjacent ANSPs, destination Airport, Airline concerned). A number of local INAP actors (minimum 5 ANSPs in the core area) will be able to apply the full set of the DCB toolset. The project will be performed in two phases: live traffic verification, in shadow mode, followed by live trials.

The VLD will demonstrate aspects that implement a set of enhanced DCB procedures supported by automated tools, including hotspot detection, identification of the most appropriate STAM and reconciliation of multiple local DCB constraints. Local DCB tools will be connected to NM systems via SWIM, and offer a tool box of STAM measures, including time modification, trajectory modification, capacity measures and tools to support enhanced DCB.

2.5.3 Advanced Air Traffic Services

Multi-FAB Free Routing *within low to high complexity environments with full support of optimised descent profiles*

The aim of this VLD is to demonstrate Free Routing in increasingly-complex and geographically wider environments. It builds on core SESAR project activities, on current national/FAB implementations (*e.g.* FABEC, UK/Ireland and Denmark/Sweden) and on several past demonstration activities. The VLD proposes an incremental approach, starting from a low level of complexity to be gradually increased as it moves from direct routing involving a single ANSP during a specified period of time with low traffic conditions, to large-scale Free Route exercises involving more ANSPs and FABs.

The VLD will use Public Live Trials, offering publicly available routing options open for many stakeholders. Consequently, the very large scale demonstration will provide results based on real-life daily operations. The very large scale demonstration shall fully validate the feasibility of the Concept of Operation in support of the PCP implementation objectives.

The VLD will also address closely-related topics, such as flexible airspace management, where Advanced Flexible Use of Airspace (AFUA) processes impact on the free routes proposed by airspace users, and Continuous Descent Operations (CDO), where Extended Arrival Management (E-AMAN) pushes the top-of-descent point upstream into the en-route sector.

Extended AMAN

The aim of this VLD is to demonstrate the Extended AMAN (E-AMAN) concept in complex TMAs featuring SESAR-validated optimized PBN structures. Two or more upstream ANSPs will be involved, in order to develop and demonstrate multi-ANSP, delay-sharing strategies, as well as data sharing in Europe's highly demanding interoperability environment. SWIM services will be used for ground-ground data exchange. The very large scale demonstration will involve a suitable number of airlines, airports and airspace configurations, and will require that each AMAN system is tailored and fine-tuned for its particular environment.

The Extended AMAN concept has been validated to V3 level by SESAR, but Europe's multi-ANSP landscape is a challenging environment for its implementation. An E-AMAN horizon of 45 minutes or greater requires the TMA-located AMAN tool to sequence aircraft that are overflying airspace under control of a different (upstream) ANSP. Sometimes, there is no common boundary between the TMA and the ANSP currently providing service to the aircraft, because one or more ANSPs are in between. Estimated Arrival Times (ETAs) will be passed downstream from the controlling Air Traffic Service Unit (ATSU) to the destination TMA to feed their AMAN; AMAN-constraints, in turn, will be sent upstream to the controlling ATSU in order to be implemented. When more than one upstream ATSU are involved, delay apportionment strategies will be demonstrated.

2.5.4 Enabling Aviation Infrastructure

Initial Trajectory Sharing

The aim this project is to demonstrate the value of using a combination of advanced ATC tools, and related enhanced operations, that are at the heart of Ground-based separation Management and Arrival Management studied in SESAR. The project will set up the combination and synchronization of key Air and Ground functionalities in order to demonstrate a global improvement in ATC tool performance based on an enhanced ground Trajectory Predictor (TP), fed with much more accurate aircraft 4D trajectory information.

Enhancements to the TP will be derived from extended flight plan (EFPL) information, supplied by the FOC, and Extended Projected Profile (EPP) information downlinked directly from the aircraft. Enhanced information will be shared among stakeholders via mechanisms with great synergy with the project proposed for Flight Object Interoperability.

Stakeholder involvement will include at least one FOC, enough EPP-equipped aircraft to provide significant results, the Network Manager Operations Centre and the flow, planning and executive controllers from multiple ATC agencies, working in varying densities and complexities. Adjacent agencies will be involved to demonstrate the efficacy of cross-border information sharing.

Exercises of increasing complexity will demonstrate improvements to the following functionalities, each functionality being added to the previous exercise: trajectory prediction, conformance monitoring, conflict detection, conflict resolution, and arrival management. Expected benefits will be an improvement in flight efficiency and safety, and an increase in airport and airspace capacity.

Flight Object Interoperability

The objective of this project is to ensure that FO-IOP works in the real operational environment of several ACCs, thus demonstrating it is sufficiently reliable, meets performance expectations and it supports the ACCs daily operational functions and procedures. This includes very large scale demonstration of the correct implementation of blue and yellow SWIM profiles. Furthermore it will be demonstrated that FO-IOP can be used without compatibility problems with other ATM functions, such as OLDI. This is a very important deployment aspect, because FO-IOP and OLDI are expected to co-exist in operational service for a very long transition period.

The VLD project covers both FO-IOP within European boundaries, as well as the interoperability of European systems with non-European systems. The European VLD exercises will be executed in a real operational environment with a direct impact on air traffic. Hence it is necessary to include all safety-related activities, to assure there will be no adverse impact on, or risk introduced to, air traffic. Initial exercises will be in shadow mode, followed by full live trials.

The VLD also addresses the sharing of information between European and American (North and South)/Atlantic oceanic systems in order to demonstrate not only its feasibility but also the benefits that the sharing of information produces on aspects such as flight predictability, silent coordination, etc. If not all the systems along the flight path are appropriately equipped for IOP, this very large scale demonstration will also demonstrate mechanisms for covering the gaps. Different very large scale demonstration exercises shall be performed for addressing the different boundaries to be covered, in the North Atlantic, for covering the traffic flow from/to North America via Shanwick and Santa Maria Oceanic centres, and in the South Atlantic, for covering the traffic flow from/to South America via Canarias and Santa Maria Oceanic Centres. Several instantiations of the above will be repeated by increasing the scope in a stepwise approach, in order to finally achieve the required level of IOP.

For the full value of this important very large scale demonstration to be realised, its proposed programme of work would need to continue into Wave 2.

PBN & GNSS

The goal of this very large scale demonstration is the deployment at selected European airports of satellite navigation based SIDs, STARs and approach procedures using satellite (SBAS) or ground-based (GBAS) augmentation systems. For Wave 1, accuracy will be equivalent to ILS Cat I, but allows for features that would not be possible with ILS, like Displaced Thresholds (DT), variable glide slope angles and curved approaches, including RF legs. GBAS ground equipment will be installed, and APV and GBAS procedures will be developed, tested and approved by the appropriate regulatory authorities. Availability of an initial set of SBAS and GBAS procedures will encourage aircraft equipage and flight crew training, and will be an important step towards making the advantages of APV and Cat I GBAS known to the aviation community. This very large scale demonstration will allow data collection regarding the important issue of RNP1 reversion issues.

2.5.5 Very Large Scale Demonstration Open calls

The content of open calls will be dependent on future deployment orientations and R&D results and will target in particular:

- The broader stakeholder community.
- Global interoperability very large scale demonstrations.

3 Delivering the Programme and its Results

3.1 Launching and Sustaining Exploratory Research

Funding mechanisms and participation will have to be compliant with Horizon 2020 rules, with Research and Innovation actions as well as Coordination support actions being the major instruments. However some other specific requirements may be included in the Programme 2020(e.g. specific expertise required) and therefore other instruments such as prizes and procurements will be used on a case to case basis (for example when a specific extension in a research project would be required or for the SESAR Young Scientist Award).

Calls will be published as for any H2020 Work programme call. Contracts will be following the H2020 model grants agreement or H2020 procurement contracts.

All calls will be open to any organisation from academia, research institute, SMEs and industry as long as their proposal satisfies the Horizon 2020 participation rules. Projects will be performed by consortia of an appropriate size and composition in accordance to the specific requirements which may be given in the work programme.

It is likely that, as for the H2020, 2014-2015 period the proposals will follow a two stage evaluation process. In the first stage outline proposals will be solicited, these will be evaluated based on the published evaluation criteria by independent experts selected by the SESAR JU. Evaluator briefings will have to be prepared by the SESAR JU as these briefings are crucial to convey the SESAR priorities so that the independent experts would be in the best position when making their evaluation. The process can be summarised as follows:

- Stage I - Proposals successful in the first stage will be invited to submit a complete technical and financial tender. Evaluation of these technical proposals will also be done by independent experts. The highest ranked proposals within the budget will be retained.
- Stage II - based on H2020 2-stage calls it is assumed that the complete process from publication of the call to awarding the contracts will be of the order of 9 months. (Process subject to validation in accordance with H2020 rules).

Project funding based on WP-E experience could be classified into two types of projects for ATM Excellent Science & Outreach (small) and for Applications-oriented research to an increased budget.

Calls for support activities are of a different nature to the R&I actions. In general they are more prescriptive, more targeted, and the activities may have durations either significantly shorter or significantly longer than those indicated for projects.

For network activities in particular, where an objective is to help build and strengthen the research community, there will be specific requirements that describe the size and composition of the consortium. The CSA will follow a one stage evaluation process.

For the more specific procurement actions, a 1 stage process will be followed where the SJU will be in charge of the selection of the proposals and the results of the action will be the property of the EU.

Project and procurement calls could be launched in 2014, 2016 and 2018 with project kick-offs 2015, 2017 and 2019 respectively.

3.2 Establishing the SESAR Partnership

In order to establish the new SESAR Partnership, in accordance with the requests of the Council and the European Parliament which led to the legal extension of the SJU, the SJU will launch a call for expression of interest for candidate members in accordance with Article 1 of its Statutes.

The selected candidate members will be required to participate to a phase of negotiation which will result in a refinement of the SESAR Programme 2020 content as well as a definition of the legal, financial and operational framework governing the Programme.

This phase is expected to last between October – December 2014 and it will be followed by the launch for a call for a binding and final offer where the candidate members will be required to commit their resources for the full scope of the Programme overall but specifically for the first wave of the projects planned between mid-2015 and end of 2017.

The conclusion of this call will result in the establishment of the SESAR Membership that will be performing the Programme activities identified here above in the period 2015 – 2024 at the latest.

The selected candidate Members not yet Members of the SJU will be allowed to participate as observers to the meeting of the Administrative Board,

The SJU will ensure that the most appropriate processes in terms of confidentiality, independence, transparency, equal treatment and management of conflict of interest will be in place during all the phases leading to the establishment of the new membership.

3.3 Governance & Decision-Making

In order to provide adequate transparency and allocate accountability in the right places, it is necessary to establish a suitable governance approach that takes account of the role and accountabilities of the SJU Administration Board (ADB), the SJU Executive Director (ED) and then provides for the necessary advice and guidance to the ED.

The Programme 2020 will involve a large range and number of stakeholders and is collaborative in nature thus making it complex to manage. It shall ensure that the decision making power entrusted by the Statutes and the Board to the Executive Director results from a process where effective recommendations and advice are provided, decisions are applied and these are communicated through an operative structure.

The role of the ADB will remain unchanged in accordance with the SJU Statutes.

Governance should be enabled at the following levels:

- *Executive level*: key roles and responsibilities being held by the SJU Executive Director, dealing with the **stakeholder management, delivery of Programme results, high-level monitoring, contractual change control**, and overall accountability to implement the Programme from the operational and financial point of view in accordance with Article 7 of the Statutes and the Administrative Board mandate.
- *Programme level*: dealing with the monitoring and change control of **operational programme management & content**.

The overall governance and link between the two levels is performed by the SJU organisation under its Executive Director.

3.3.1 Executive Level Governance

The Executive Level is the steering authority for the SESAR Programme and is responsible for the full scope of the SJU operations and programme, including Master Plan, Delivery, Content, Quality, Administration, Finance, Legal, Institutional Stakeholders, Communication & Global outreach and includes the role of the Administration Board (not described further in this document).

Considering that the SESAR R&I Programme 2020 is established in three phases (Exploratory Research, Industrial Research & Validation and Very large Scale Demonstration) which will be subject to different processes and procedures, there is a need to ensure that for each of them the necessary adequate governance is in place, providing assurance on relevance, management conflict of interest and independence.

As a result, hereafter adequate governance is proposed to support the Executive Director and his organisation in his responsibilities in accordance to the functions entrusted to him by Article 7 of the SJU Statutes and the Administrative Board. In this respect, beyond the SJU staff organisation, the Executive Director shall be supported in execution of the role and responsibilities by a Scientific Committee, a Programme Committee and a Master Planning Committee.

3.3.2 Programme Level Governance

The Programme level consists of the governance of content and delivery of Exploratory Research, Applied Research, Pre-Industrial Development and Validation, Very Large scale Demonstration activities as well as providing specific advice and consultancy on Master Planning aspects. The Programme level supports and advises the Executive Director and his organisation in the Executive level governance with each Committee reporting to the ED and subsequently to the Executive level of the governance. The mechanisms for governance at the Programme level vary across the Programme Level depending on whether the work being performed is within or outside the scope of the MFA.

At this stage in the development of the programme the governance arrangements are to be considered as provisional. The principles of the governance presented below will be further refined along with the definition of the formal terms of reference and the detailed composition.

Scientific Committee

Covering the Exploratory Research Phase of the Programme and in order to support the Executive Director in the management of these activities, in accordance with Article 11 of the SJU Statutes a Scientific Committee is established (SC). It is chaired by the Executive Director or his delegate. The aim of the Scientific Committee is to provide support, advice and recommendations to the Executive Director on Exploratory Research, in particular on its design, implementation, monitoring, evaluation, etc.

In addition, the Executive Director may request the SC to provide scientific advice and recommendations on any domain of the SESAR R&I Programme.

In support of the need for transparent governance of Exploratory Research without direct Member intervention, the Scientific Committee operations will ensure that any potential conflict of interest is identified and managed using an established process, with escalation if necessary.

Programme Committee

It covers the Industrial Research & Validation and the Very Large Scale Demonstration phases of the Programme within the scope of the MFA and is strategic in nature, a Programme Committee is set up within the context of the Multilateral Framework Agreement and its future amendment(s).

The Programme Committee is composed of one representative per Member contributing in accordance with Article 4 – Voting in the Administrative Board to the SESAR R&I Programme activities (one representative of the EU, a representative of the AUs and a representative for each of the Selected Members as defined in the MFA). The representative thus appointed by each organisation must be duly empowered by the latter to conclude amendments to the Technical Schedules.

The Programme Committee is chaired by the SJU Executive Director, who may invite external support on an ad-hoc basis. The Programme Committee is supported by 2 sub-committees:

- Delivery Management sub-committee: dealing with the planning, execution, project management and release management. Responsible to ensure common understanding and consistent application between all project managers and supporting experts of the processes as defined in the PMP (e.g. Planning, Risks, etc.

and the application of these into validation exercises, releases and solution packaging).

- Operations & Technical sub-committee: responsible to undertake the necessary actions to address content related issues identified in the Programme and to deal with operational, system and architecture development content.

ATM Master Planning Committee

In addition to the specific R&I activities, the SJU is entrusted in accordance with the Council Regulation amending regulation 219/2007 considering the SJU extension to 2024,as the "guardian" and the executor of the European ATM Master Plan.

While during the previous years the Master Plan review exercise was performed on an ad hoc basis, considering the start of the deployment phase as well as the entrance of new key player(s) entrusted with the management of the SESAR Deployment, it appears necessary to avail the SJU and his Executive Director with high level advice and recommendation on the Master Planning activities and advise on its revision. One of the key objectives is also to anticipate and de-risk the evolution of the R&I results towards deployment projects.

The objective of the ATM Master Planning Committee, to be established as SJU working group in accordance with Article 11 of the SJU Statutes, should provide advice and recommendations to the SJU Executive Director on the progress of the implementation of the European ATM Master Plan. It should be the Committee ensuring the necessary bridge between the Programme R&I 2020 activities and the Deployment Activities.

Composition and selection of the Committee and the formal terms of reference for operation will be developed later, including the specific means of avoiding any conflict of interest. The Committee will include relevant key stakeholders not part of the SESAR membership.

3.4 Content & Delivery Management

3.4.1 Content Management

This builds upon the existing programme to strengthen the top-down view of the performance required and the operational, technical and architectural options suitable to achieve this with appropriate SESAR Solutions.

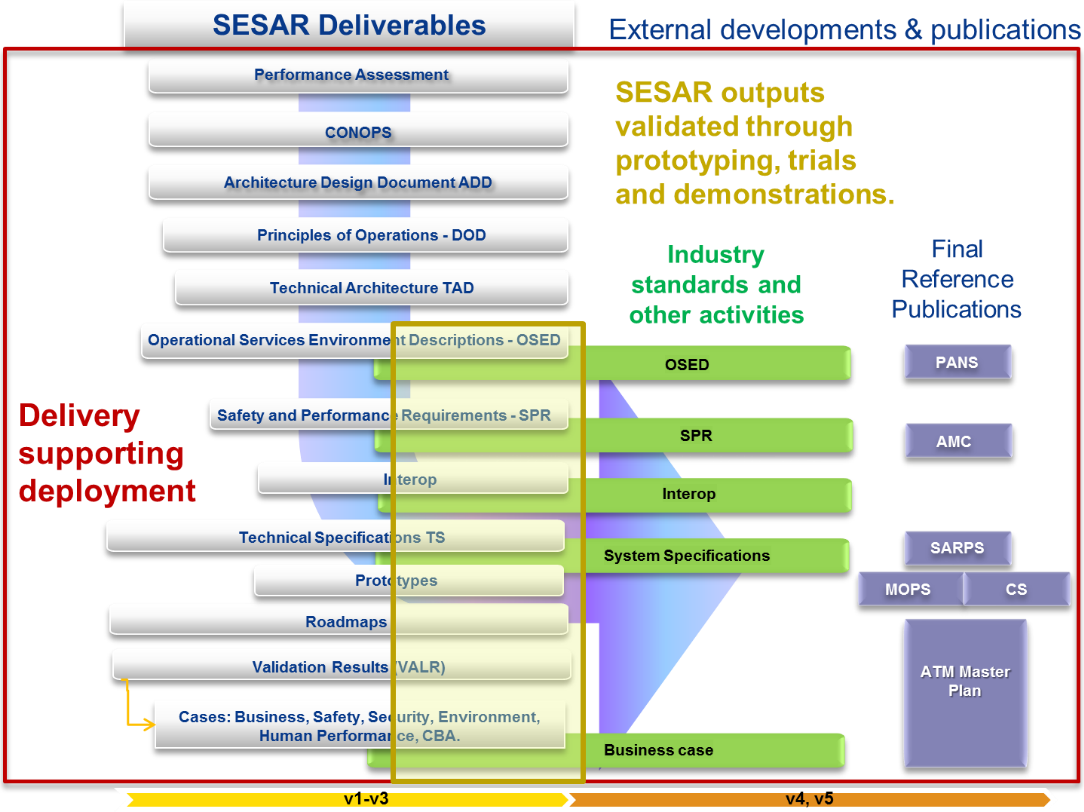
Covering ATM/CNS and its respective operations, systems and technology as well as the architectural design and integration, the SJU will ensure strong links to activities performed in transversal activities of 'ATM Design & Integration' and Performance Management, establishing robust and validated SESAR solutions.

In partnership with Members and stakeholders the SJU will establish a new operations & technical review group to provide a forum for discussing and resolving operational and technical issues with the objective of achieving the overall programme business priorities and maximising the benefit from the SESAR solutions being researched and developed in the programme.

The output of the Programme is defined and packed in the form of SESAR Solutions. SESAR Solutions contain V3 mature R&D materials that support a decision step on industrialisation and/or deployment. They relate to either an Operational Improvement (OI) or a group of OI with their Enablers (technical system, procedure or human), that will deliver business benefit to the European ATM, when translated into their effective realisation.

In order to show on a larger scale the benefits of the SESAR Solutions, large scale Demonstrations activities bring them into more operational environments to increase visibility and buy-in amongst the ATM community.

SESAR Solutions include deliverables validated through prototyping, trials and large scale demonstrations that describe the content and communicate the results of SESAR Development to a wide range of stakeholders. This is represented in the chart below:

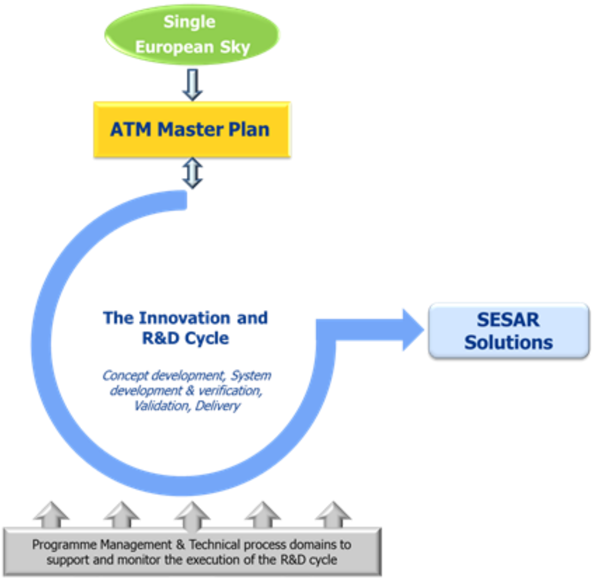


Furthermore established links (through dedicated agreements and via the Members) with standardisation and regulatory bodies will be maintained and enhanced, engaging external 3rd parties to provide support on content analysis, development, timing, refinement and review, as required.

The real success of the SESAR Solutions is determined only once industrialisation, deployment and the successful delivery of the operational, technical and/or business benefits for the respective stakeholders has taken place. Consequently the SJU will establish an effective link to all ATM stakeholders undertaking deployment, in particular the Deployment Manager. This is to ensure the continuity of operations and technical information flow, as well as feedback to the SJU from these organisations to help with the improvement of ongoing activities that lead to new SESAR Solutions.

3.4.2 Delivery Management

Although some refinement can be anticipated before the launch of the SESAR 2020 Programme, the delivery process is foreseen to largely rely on the current SESAR Innovation and R&D Cycle supported by the SJU Programme Management Framework. Building on this approach and ensuring that it is effective in both assuring the content as well as delivering in accordance with best-practice project and programme management principles and practices, the delivery management can be summarised as follows:



The SESAR Innovation and R&D cycle represents a sequence of major events enabling the research and development of SESAR Solutions from their initial definition to their confirmed readiness for further industrialisation and deployment, in response to strategic objectives set in the ATM Master Plan.

The SESAR Programme lifecycle starts with strategic direction setting, derived from the ATM Master Plan. As part of the ATM Master Plan, the Integrated Roadmap further details the Operational Improvements and related Enablers. In addition, ATM Master Plan defines the SESAR contribution to the Single European Sky High Level Goals in terms of Performance Needs. These Performance Needs are broken down into a more detailed level and translated into performance validation targets to be achieved by the SESAR projects.

The preparation and execution of the validation and verification exercises allow proving fitness for purpose of the operational and technical content towards the Operational Improvements and Enablers. Results of validation activities are analysed to provide evidence of whether the validation objectives have been achieved and if performance expectations have been met. The performance results are consolidated and a gap analysis is performed leading to reviewing the validation targets and the performance needs, culminating in the population of the SESAR Solutions.

Supporting the Innovation and R&D Cycle, the SJU Programme Management framework is to focus on the planning, monitoring and control of programme and project:

- The “Planning” domain covers all activities associated with the follow-up and maintenance of the Programme and projects plans;
- The “Execution and Control” domain to ensure the projects activities and results adhere to the SJU Programme Management framework and meets the SJU expectations and that deviations are duly justified and recorded in auditable terms. In particular, common definition of shared information elements and their configuration management is performed through the Programme Information Reference Model (PIRM);
- The “Monitoring” domain covers all activities focussing with the measurement and monitoring of the Programme including in particular Risk Management that result in the identification and subsequent implementation of mitigation measures.

3.5 Master Planning

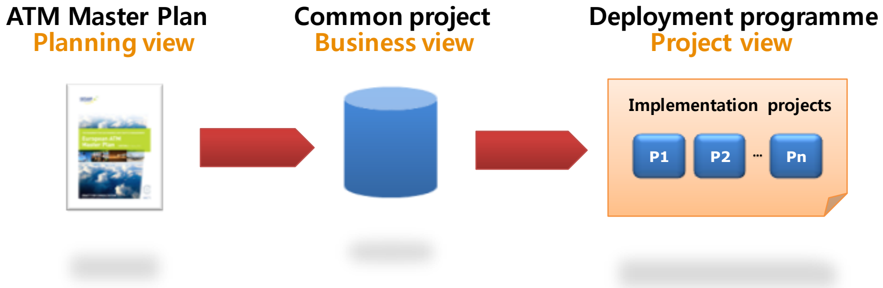
This section presents the means of undertaking the work necessary to establish deployment orientation and readiness to transfer results to the Deployment Manager and others.

3.5.1 Master Plan Maintenance

The European ATM Master Plan is the roadmap driving the modernisation of Air Traffic Management and governing the transition from research to deployment. It is the basis for the new generation of European ATM systems for 2030 that will help achieve "more sustainable and performing aviation" in Europe.

The plan contains roadmaps which are regularly updated for the essential operational and technological changes required from all stakeholders (airspace users, ANSPs, airport operators, the military and the network manager) to achieve the performance objectives set by the Single European Sky (SES). Through various mechanisms, it ensures alignment with ICAO's Aviation System Block Upgrades (ASBU) for global interoperability and synchronisation.

It has been demonstrated that only the timely, synchronised and coordinated deployment of SESAR in accordance with the Master Plan will contribute to achieving the SES performance. To that end, the Commission has established the Policy level of the deployment governance, which is under its direct responsibility. In the governance model, the Commission, representing the political level of the deployment governance, is responsible for establishing common projects which will become a primary instrument for SESAR deployment. For this purpose, common projects cover those essential operational changes identified in the European ATM Master Plan with the sufficient maturity and justification to be deployed at European level.



Setting the content of Common Projects includes selecting the essential ATM functionalities identified in the European ATM Master Plan that, having completed their research, development and validation cycle through the work of the SJU have demonstrated their readiness for deployment. The SJU will put in place the necessary arrangements to ensure efficient and effective ATM Master Plan monitoring process.

3.5.2 Economic Analysis & Business Cases

The demonstration of a globally positive CBA plays a central role in de-risking the transition from research to deployment. In order to anticipate deployment related decisions the Innovation and R&D cycle will be further developed to cater for decision making needs all the way to the pre-identification of future Common Project proposals.

At European ATM Master Plan level a high-level view of the business implications of SESAR will be provided with a focus on the impact of SESAR changes in terms of benefits, cost and business model evolution.

3.5.3 Risk Management

Although the overall complexity of the Programme managed by the SJU with its Members, in terms of organization, content and resource management will be reduced in SESAR 2020 it requires that an adequate Risk Management processes is put in place also capturing any critical risks highlighted through SESAR deployment reporting mechanisms.

A significant review of the SESAR 2020 Programme and SJU risks will be performed in the context of the European ATM Master Plan edition 2015 update campaign. The purpose of this exercise will be to review key risk areas, to assess the status of the most critical risks, and to define appropriate mitigation actions.

Taking the above into consideration the SJU will utilise and enhance where required its existing internal risk control framework for effective operations with procedures applicable at all levels of the management. This framework involves the stakeholders of the partnership and complies with the standards adopted by the Administrative Board on the basis of equivalent standards laid down by the Commission (e.g. identification and assessment of risk, issues and opportunities). Specifically, the SJU Decision (ED64) on Internal Control Framework and Risk Management Policy confirms alignment with the requirements of the European Commission as indicated in the Communication SEC(2005)1327 – Towards an effective and coherent risk management in the Commission services.

Appendix A Acronyms

Acronym	Description
DAP	Downlinked Aircraft Parameter
DBS	Distance Based Separation
DCT	Direct Route
DFS	Deutsche Flugsicherung GmbH
DAP	Downlinked Aircraft Parameter
DBS	Distance Based Separation
DCT	Direct Route
DFS	Deutsche Flugsicherung GmbH
DIMT	De-Icing Management Tool
DMA	Dynamic Mobile Area
DMAN	Departure Manager
DME	Distance Measurement Equipment
DoW	Description of Work
DP	Data Processing
DP	Departure Procedure
DT	Displaced Threshold
E-AMAN	Extended-AMAN
EASA	European Aviation Safety Agency
EATMA	European ATM Architecture
EC	European Commission
ECAC	European Civil Aviation Conference
EFPL	Extended Flight Plan
E-FPLN	Extended Flight Plan
EGNOS	European Geostationary Navigation Overlay Service
E-OCVM	European Operational Concept Validation Methodology
ER2020	Exploratory Research in Programme 2020
ESSIP	European Single Sky Implementation Plan
ESVS	Enhanced Synthetic Vision System
ETA	Estimated Time of Arrival
EU	European Union
EUR	ICAO European Region
EUROCAE	European Organisation for Civil Aviation Equipment
EVS	Enhanced Vision System
EXE	Exercise
FAA	Federal Aviation Administration (USA)
FAB	Functional Airspace Block
FABEC	Functional Airspace Block Europe Central
FDP	Flight Data Processing
FF	Flight and Flow
FF-ICE	Flight and Flow Information for the Collaborative Environment concept
FIM	Flight deck based Interval Management

Acronym	Description
FIR	Flight Information Region
FIXM	Flight Information Exchange Model
FIX-M	Flight Information Exchange Model
FM	Flow Management
FMP	Flow Management Position
FMS	Flight Management System
FO	Flight Object
FO-IOP	Flight Object - Interoperability
FP7	Framework Programme 7
FPL	Flight Plan message (ICAO format)
FPLN	Flight Plan
FTS	Fast-time Simulation
FUA	Flexible Use of Airspace
G/G	Ground-Ground
GA	General Aviation
GA/R	General Aviation & Rotorcraft
GEN	General
G-G	Ground-Ground
GLS	GBAS Landing System
GNSS	Global Navigation Satellite System
GNSS/GBAS	Global Navigation Satellite System, Ground Based Augmentation System
GSM	Global System for Mobile Communications
H2020	Horizon 2020
H24	Hours 24: Availability 24 hours/day, 7 days/week
H24/D7	Hours 24: Availability 24 hours/day, 7 days/week
HMI	Human-Machine Interface
HP	Human Performance
HUD	Head Up Display
IAA	Irish Airports Authority
IBP	Industrial Based Platform
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Interval Management
IMC	Instrument Meteorological Conditions
IM-S&M	Interval Management- Sequencing and Merging
IN	Included
INAP	Integrated Network Management and extended ATC Planning Function
INTEROP	Interoperability Document (Requirements)
IOP	Interoperability
IPS	Internet Protocol Suite
IPv6	Internet Protocol version 6

Acronym	Description
IR	Implementing Rules
iRBT	Initial Reference Business Trajectory
iRMT	Initial Reference Mission Trajectory
IRS	Interface Requirements Specification
ITS	IT Security System
IWIS	Integrated Weather Information System
JPALS	Joint Precision Approach and Landing System
JU	Joint Undertaking
KPA	Key Performance Area
KPI	Key Performance Indicator
KTN	Knowledge Transfer Network
L1	Level 1 elements
L3	Level 3 elements
LC	Low Capacity
LIDAR	Light Detection And Ranging
LOA	Letter Of Agreement
LPV	Localiser Performance with Vertical guidance
LPV	Localizer Performance with Vertical Guidance
LPV	Lateral Precision with Vertical Guidance Approach
LTM	Local Traffic Management Role
LVC	Low Visibility Conditions
LVP	Low Visibility Procedure
NAF	NATO Architecture Framework
NATO	North Atlantic Treaty Organisation
NATS	National Air Traffic Services (UK)
NAV	Navigation
NAV	NATO All View
NEFAB	North European FAB
NEXTGEN	Next Generation Air Transportation System (FAA)
NEXT-GEN	The US ATM Change Programme
NM	Network Manager
NMF	Network Management Function
NMOC	Network Management Operation Center
NOP	Network Operations Plan (Portal)
NOP/AOP	Network Operations Plan/Airport Operations Plan
NOTAM	Notice to Airmen
NSA	National Supervisory Agencies
OCVM	Operational Concept Validation Methodology
OI	Operational Improvement
OJT	On the Job Training
OLDI	On-Line Data Interchange
OPS	Operations
OPS/ATM	Operations / Air Traffic Management
Q2	Second Quarter Timeframe

Acronym	Description
Q3	Third Quarter Timeframe
Q4	Fouth Quarter Timeframe
R	Restricted Area
R&D	Research and Development
R&I	Research and Innovation
R/T	Radio Telephony
R/T	Radio Telephony
R3	Release 3
R4	Release 4
RA	Resolution Advisory
RAD	Route Availability Document
RBT	Reference Business Trajectory
RBT/RMT	Reference Business Trajectory/Reference Mission Trajectory
RBT/SBT	Reference Business Trajectory/Shared Business Trajectory
REL	Runway Entrance Lights
RF	Radio Frequency
RIL	Runway Intersection Lights
RMAN	Runway Manager
RMT	Reference Mission Trajectory
RN	Required Navigation
ROT	Runway Occupancy Time
RP	Reference Period (EC performance scheme)
RP2	Second Reference Period
RPAS	Remotely Piloted Aircraft System
RTCA	Radio Technical Commission for Aeronautics
RTCA/EUROCAE	The respective US and EU Standards Organisations
RTM	Multiple Remote Tower Prototype
RTS	Real-time Simulation
RVR	Runway Visual Range
RWSL	Runway Status Light
RWY	Runway
S&M	Sequencing & Merging
SARP	Standard and Recommended Practices
SARPS	Standards And Recommended Practices (ICAO)
SatCOM	Satellite Communication
SBT	Shared Business Trajectory
SBT/RBT	Shared Business Trajectory/Reference Business Trajectory
SBT/SMT	Shared Business Trajectory/Shared Mission Trajectory
SE	System Engineering
SES	Single European Sky
SESAR	Single European Sky ATM Research
SESAR1	The first SESAR Programme
SESAR2020	The second SESAR Programme
SESAR-NEXTGEN	The respective European Union - United States of America ATM

Acronym	Description
	Change Programmes
SID	Standard Instrument Departure
SID/STAR	Standard Instrument Departure Route/Standard Terminal Arrival Route
SJU	SESAR Joint Undertaking
SMAN	Surface Manager
SME	Small & Medium Enterprise
SMGCS	Surface Movement Guidance and Control System
SMT	Shared Mission Trajectory
SNET	Safety Net
SOA	Service Oriented Architecture/Approach
SPBN	Strategic Priority Business Needs
SPR	Safety and Performance Requirements
SPR/INTEROP	Safety and Performance Requirements/Interoperability
S-PWS	Static Pair-Wise Separation
STAM	Short-Term ATFM Measures
STAR	Standard Terminal Arrival Route
STAR	Safety Target Achievement Roadmap
STCA	Short Term Conflict Alert
STCA/MTCD	Short Term Conflict Alert/Medium Term Conflict Detection
SUA	Surveillance Area
SUR	Surveillance
SVS	Synthetic Vision System
SWIM	System-Wide Information Management
SWIM/NOP	System Wide Information Management/Network Operations Plan
TRL	Technology Readiness Level
UAC	Upper Area Control Centre
UAV	Unmanned Aircraft Vehicle
UIR	Upper Flight Information Region
UK	The United Kingdom
VLSD / VLD	Very Large Scale Demonstration
WAM	Wide Area Multilateration
WBS	Work Breakdown Structure
WDS	Weather Dependent Separation
WIS	Weather Information System
WOC	Wing Operations Centre
WXXM	Weather Information Exchange Model

Appendix B High-Level Definitions of Work – Industrial Research

1 Introduction

The following section presents the High Level Definitions of Work (DOW) for each project in terms of Problem Statement, High Level Solution Description and Performance Goals.

2 Additional Guidance

In order to avoid repeating similar text in most of the DOWs, additional guidance has been defined here below. They mainly apply to the SESAR Solution Projects[2].

The SESAR solution projects encompass all the operational and technical activities. They shall adopt a performance driven approach by using the Validation Targets allocated to their solutions and providing results in accordance with the SESAR 2020 performance framework. Reference scenario used during validation activities shall be defined (e.g. 2013 traffic situation). It will enable to clearly identify the performance benefits stemming from the exercises and to compare the benefits against the baseline (current baseline is the 2005 traffic situation).

The SESAR solution projects are responsible for planning, budgeting and resourcing the performance assessment activities needed to develop their solutions (including transversal Area such as safety, security, environment, HP). They shall apply and conform to the SESAR 2020 Reference Material when executing the Transversal Area assessment. The SESAR 2020 Reference Material will be defined at the time of the Call for Tender for a given wave and remain stable during the whole duration of that wave.

The SESAR solution projects shall address the operational aspects related to the integration of all airspace user types, including RPAS, GA and rotorcraft users relevant to the scope under the responsibility of this project. Technical solutions delivered by project PJ13 Air Vehicle Systems and operational aspects will have to be subject to integrated validations.

The SESAR solution projects shall identify relevant CNS-related dependencies and requirements to support the development of CNS enablers that will be required in order to achieve the full V3 maturity of the OI step(s) under their scope. The PJ14 CNS project will collect all those CNS-related dependencies and requirements, ensure their consistency, provide feedback on their achievability and will develop the prototypes required to support the validation activities.

SESAR Solution projects shall identify MET/AIM related requirements and take into consideration, when required, MET/AIM new capabilities and/or MET/AIM information in their validation activities as defined by PJ19 ATM Design & Integration. Similarly, SESAR Solution projects shall contribute to the identification, development, implementation and validation of relevant SWIM services.

The industrial development of the validation platforms supporting the validation activities (e.g. IBPs) is the responsibility of each SESAR Solution project: identification of V&VI needs and User requirements, IBP evolution plans, integration/verification plan and tests, etc. SESAR Solution projects shall follow the methodology proposed by Project P22 Validation,

[2] SESAR Solutions projects refer to the Projects belonging to the 3 Key Features that are the High Performing Airport Operations, the Optimised ATM Network Management and the Advanced Air Traffic Services.

Verification & Very Large Scale Demonstration Infrastructure and apply it in their activities, producing the required documentation and evidences to support System Engineering review.

SESAR Solution projects, in coordination with other SESAR Solution projects, are in charge of defining, detailing, planning and executing the integrated validation activities required to complete the validation of the SESAR solutions under their scope. Integrated Validation Activities are validation activities that address a group of OI steps that are under the scope of different SESAR Solution projects. Each Integrated Validation activity shall be under the responsibility of one SESAR Solution project and one lead exercise coordinator but shall address validation objectives for all relevant SESAR Solution projects impacted by the results of the activity.

When relevant, the SESAR solution projects shall develop the input that will contribute to the standardization activities conducted by the standardization bodies in accordance with the SESAR deliverable framework (e.g. SPR/INTEROP, TS/IRS).

To ensure that the worthy results and work of each project is well communicated, the projects will plan resources dedicated to communications activities. Projects will be provided with communications guidelines by the SJU.

3 Project Descriptions

Dependencies between projects will be essential to support the integration and the synchronisation between the various contributions. These dependencies can be of a “vertical” nature linking the SESAR Solutions projects to the Transversal projects (e.g. allocation of validation targets and consolidation of the performance results) or based on an “horizontal” relationship between SESAR solutions projects (e.g. elicitation of operational requirements provided by different projects for developing the technical solutions enabling integration of civil Remotely Piloted Aircraft Systems (RPAS) into the ATM environment).

These dependencies are not accurately defined in the current High Level DOWs. However, they will be identified and listed into the detailed DOWs.

3.1 PJ01 – Enhanced Arrivals and Departures

PJ.01	Enhanced Arrivals and Departures
Problem Statement	

SESAR1 focused on:

- Extending the AMAN horizon to En-Route sectors (including across borders) for a single TMA, enabling some of the queuing time to be absorbed further upstream and improving fuel efficiency and predictability. The extension of the horizon involves a transfer of workload to the En-Route sectors and relies mainly on two delay absorption techniques:
    - Time To Lose/Time To Gain (TTL/TTG) controller advice, or
    - Controlled Time of Arrival (CTA) (in a medium complexity/medium density environment). CTA may be supported in an Initial 4D environment by datalink exchange and the downlink of onboard 4D trajectory data, where aircraft are suitably equipped.
- Making use of enhanced departure information to enable a more consistent and manageable delivery of departures into the En-Route phase of flight.
- ASPA Interval Management, Sequencing and Merging (ASPA-IM-S&M) procedures using simple geometry, whereby controllers instruct the flight crew to achieve and maintain a given spacing with a designated target aircraft. Separation provision remains the responsibility of the controller.
- Use of PRNAV procedures such as Point Merge or Tromboning to provide high runway throughput
- Progressive implementation of procedures enabling increased use of CDO/CCO in higher density traffic or from/to higher levels, optimised for each airport arrival/departure procedure
- Provision of RNP1 SIDs and STARs and redefined holding areas, contributing to improved capacity and safety, and reduced environmental impact. Additionally, the optimisation of the route structure using A-RNP to reduce spacing between routes.
- Use of APV to improve safety and airport accessibility, and advanced RNP transitions onto final approach enabling reduced track miles in the terminal area and relaxed airport constraints due to noise restrictions.

Remaining improvements to be addressed

With the extension of AMAN horizons, En-Route sectors are affected by concurrent arrival management strategies due to the overlapping AMAN horizons of several independent TMAs, and at the same time need to consider the impact on non-arrival traffic within the sector as well as Network Management constraints/activities.CTA as defined in medium density may not be feasible in a high density/complexity environment without improved automation and advanced support tools.

The interaction between Traffic Synchronisation and DCB needs to be addressed, in particular with respect to TTA. Complex interacting traffic flows in the TMA, including arrival flows into multiple airports in the same vicinity, need to be actively managed to increase safety, capacity and fuel efficiency. A constraining TMA route structure is required for high complexity/density operations, however this can result in insufficient accommodation of different climb and descent profiles resulting in a lack of optimisation of efficiency.

ATM operations in high density/complexity environments have a sub-optimal performance due to the continued necessity to use stepped climbs and descents for some flights, arising from the high traffic complexity and density. This consequently leads to an increased tactical operation which in turn leads to a reduced performance in terms of increased workload, increased fuel consumption and cost for the airspace user and the consequential increase of noise impact, CO_2 and NOx emissions for arriving and departing aircraft.

To further increase its benefits such as decreased controller workload and more regular flow to the runway, ASAS S&M applications will need to include the use of lateral manoeuvres and will need to handle aircraft flying more complex geometry.

High level solution description

SESAR2020 "**Enhanced Arrivals And Departures**":

- Integrates information from multiple arrival management systems operating out to extended range into En-Route sectors with local traffic/sector information and balances the needs of each. Use of SWIM infrastructure will be required
- Addresses the interaction between Traffic Synchronisation and DCB, including identification of cross integration needs
- Extends the use of time constraints (e.g. CTAs) to high density environments using datalink exchange and the downlink of onboard 4D trajectory data
- Validates new ASPA-IM-S&M manoeuvres including lateral manoeuvres and involving more complex geometries. The operational scope of the ASPA-FIM (DO-195 update and the MOPS expected to be published in 2015) should be taken into account in later refinement of the plans
- Provides automated support to departure metering to enable a more consistent and manageable delivery into the En-Route phase of flight and provides assistance tools to coordinate complex interacting traffic flows within the TMA
- Brings together vertical and lateral profile issues in both the en route and TMA phases of flight, with a view to creating an end to end optimised profile and ensuring transition between Free Route Airspace and Fixed route airspace. Dynamic terminal airspace accommodates differing traffic and capacity constraints (e.g. dense and complex TMAs ranging to low demand TMAs)
- Provides new controller tools and enhanced airborne functionalities to facilitate CDO from ToD and CCO to ToC
- Optimises Low Level IFR route network for rotorcraft using RNP-1 / RNP-0.3
- Complements Fixed SID/STARs with dynamic departures/arrival routes (in Low density TMAs, Medium density TMAs (to be explored)
- Enables interoperability of the new operations/capabilities and evaluation of the compound benefits.
- Provides procedures and support systems to integrate RPAS / GA / Rotorcraft operations in a seamless way within the TMA

"**Enhanced Arrivals And Departures**" does not include the integration of arrival and departure sequences for the same runway or dependent runways. This integration is addressed by "Integrated Surface Management".

Performance Goals

- Environmental Sustainability / Fuel Efficiency (Fuel Burn per Flight)
- Airspace Capacity (Throughput / Airspace Volume & Time)
- Airport Capacity (Runway Throughput Flights /hour)
- Predictability (Flight Duration Variability, against RBT)
- Cost Effectiveness (Direct ANS Cost/Flight)
- Safety (Total absolute number of fatal accidents with ATM contribution)

3.2 PJ02 – Enhanced Runway Throughput

PJ.02	Enhanced Runway Throughput
Problem Statement	

Traffic demand on runway operations exceeds the runway capacity at capacity constrained airports. With the growth in air traffic there is an increasing number of airports that are becoming capacity constrained for significant periods of each day. Therefore, there is pressure to improve the efficiency of runway operations. The main related issues are listed here:

- Current static ICAO Wake Vortex separation minima seems too conservative and not optimised to airport current fleet-mix. Furthermore, future re-categorised wake and weather based separation minima based on static and dynamic aircraft characteristics (respectively Static Pair-Wise Separation (S-PWS) & Dynamic Pair-Wise Separation (D-PWS)) will be constrained by Runway Occupancy Time (ROT) and lack of concept and system integration. Use of differentiated glide paths and displaced touch down for two arriving aircraft will reduce risk of Wake turbulence encounter and thus need for reduced separations.

  SESAR 1 will deliver RECAT 2 (S-PWS) however, only early integration with system support will have been achieved. RECAT 3 (D-PWS) will be delivered only to draft concept maturity. SESAR 1 will deliver adaptive thresholds and glide slopes concepts using GBAS to V2 maturity.

- Minimum Radar Separation (MRS) on final approach is a constraining factor under some conditions for some pairs. Significant efficiency benefits can result from this being reduced.

  SESAR 1 will deliver V2 maturity on 2NM MRS. Significant technical and operational validation will be required together with integration with the concepts addressed above.

- Runway Occupancy Time (ROT) is impacted by uncertainty of the runway exit point for arrivals and, therefore, the time an aircraft will spend on the runway which can lead to 'go arounds' and poor runway optimisation. In addition, surface movement planning is complicated by uncertainty over the landing, roll-out, exit and taxi phases.

  SESAR 1 has delivered V2 maturity of Enhanced Braking System (EBS). Further work is required to consider ground based ROT prediction systems to cover the interim lack of equipped EBS aircraft together with full V3 validation of EBS. Work also needs to be carried out to review taxiway positioning and design for supporting Heavy and Super-Heavy aircraft types.

- Optimisation of the arrivals and departures in mixed mode runway operations will also rely on considering the ROT and Time-Based Separation information together with the Arrival, Departure and Surface Management.

Resilience of operations to challenging operating conditions is becoming increasingly important due to the unacceptable impact on the predictability and efficiency of operations. In particular:

- Weather conditions such as head and crosswinds or low visibility conditions, can lead to reduced landing rates, increases in arrival delays or even flight cancellations.

  SESAR 1 has delivered Time Based Separation for headwind resilience to V3 maturity. Weather Dependent Separation (cross winds) for arrivals and departures facilitating reduced wake separations is expected to achieve V3 maturity in SESAR 1. However full integration with ROT, wake, TBS and system support will require further validation.

  For visually challenging conditions there is a need to:

  - Extend the application of the current 2.5NM and the new 2NM Minimum Radar Separation (MRS) to Low Visibility Conditions.
  - Eliminate the need for additional separation due to ILS protection area (to avoid problems of interferences and electromagnetic compatibility) through the applications of GBAS for instrument approach.
  - Address ensuring consistent runway occupancy profiles across visually challenging conditions.

- Address the time spacing resilience of the clearance to land procedures in challenging visual conditions.

High level solution description

The development of the operational concept, procedures and associated technology will allow an improvement in the management of arriving and departing flights with the focus on reducing the runway occupancy time thus increasing runway throughput.

Regarding the Wake Vortex separation minima, an incremental approach is expected to be established through the implementation of the following steps:

- The validation of full "time based separation" incorporating RECAT wake turbulence separation minima with either the new 6 category (RECAT EU) or the full RECAT 2 wake matrix of static pair wise separation, fully integrated with system support and TBS.
- The optimisation of the full RECAT 2 matrix to give the ANSPs the opportunity to form category groupings based on the local fleet mix and capacity needs with the ability to adapt to changes in fleet mix over time. This should be fully integrated with system support and TBS;
- Full application of weather dependent separation (WDS) for both departures and arrivals on final approach, taking into account any meteorological conditions (e.g. crosswind), integrated with system support, RECAT EU / RECAT 2 / Optimised Categories and TBS;
- Wake Separation based on Dynamic Aircraft Characteristics (RECAT-3) affected by the real-time weather conditions and incorporating data from air and ground systems
- Mitigation of noise and adaptation of wake avoidance procedures through concepts such as adaptive aiming points and adaptive glide paths which move noise into the centre of the airport and take account of wake transport. In some runway configuration scenarios this may provide additional benefit in addition to efficient wake separation rules which are currently being developed under S-PWS, D-PWS and WDS. Such concepts should be integrated with system support, TBS, WDS and RECAT

Reduction of separation minima is strictly dependent on the availability of accurate aircraft position data leading to the implementation of Required Surveillance Performance (RSP). RSP could allow for the application of non-wake turbulence pair wise separation of 2NM for arrivals on final approach. To this end, there is need to investigate the surveillance technology (e.g. GNSS/GBAS, WAM) allowing to meet the RSP requirements.

Increase the resilience to challenging visual conditions with a positive effect on predictability and efficiency of operations. Therefore there is need to:

- Extend the application of the current 2.5NM and the new 2NM Minimum Radar Separation (MRS) to IMC VIS 2 and LVC through improving the predictability of ROT in visually challenging conditions.
- Improve the predictability of ROT through the application of EBS, GBAS, and possibly visual augmentation of exit taxiway positions to the flight deck.
- Eliminate the need for additional separation for localiser protection through the application of GBAS.
- Define operational needs and requirements and validate procedures for GBAS-based operations (landing (CAT II/III) based on dual GNSS and take-off. Additionally, GBAS can also be used as surveillance system for surface movement navigation providing an increased accuracy of aircraft position on the onboard navigation display minimising the impact of bad weather conditions on surface operations.
- Address ensuring consistent runway occupancy profiles across visually challenging conditions.
- Improve the time spacing resilience of the clearance to land procedures by providing tower runway controller with an appropriate situation awareness through surveillance or visual augmentation. The idea is to implement an integrated Runway Management System based on the sharing of all the required information (including aeronautical, flight trajectory, meteorological, air traffic flow, surveillance) among all the involved stakeholders. This will be achieved through the deployment of System Wide Information Management (SWIM) concept. This integrated approach will allow in real time to both propose separation mode / minima to

the supervisor and Wake Vortex advisories to Approach and Tower Controllers.

- Improve the access into small airports in low visibility conditions through the development of an affordable GA surveillance solution and the publication of Approach Procedure with Vertical Guidance at secondary airports.

Runway Occupancy will be the main constraint to runway throughput and exploitation of the different improvements discussed above. Therefore, there is need to:

- Ensure ATC is fully aware of the expected occupancy time and exit point for each arriving aircraft and the start of roll, occupancy time and rotation for each departure. Linking to different concepts and support system will further optimise safety and runway management.
- Ensure that the aircraft is able to brake in an optimum fashion and to exit the runway at a predetermined exit;
- Improve accuracy of Runway Occupancy Time prediction by means of statistical analysis of collected and real data exploited by a predictive ground based ROT system that covers non EBS equipped aircraft and incorporates information from EBS equipped aircraft;
- Define/Identify Procedures and technology for Runway Occupancy Time (ROT) management covering both ground based prediction and EBS information down linked from arrivals and departures into the ATC system ensuring a more accurate runway use and taxi plan strategy;
- Define operational needs and procedures for use of optimised enhanced braking information at a pre-selected runway exit coordinated with Ground ATC covering both ground based prediction and EBS information from aircraft sent by Datalink. Until full implementation of airport data link, an interim approach will rely on ground based prediction that covers non EBS aircraft and then integrates EBS information down linked from equipped aircraft.
- The magnitude of the resulting benefits is strongly dependent on the availability of a full integration of Arrival/Departure management, surface management and information on final approach spacing performance to ensure traffic optimisation on the runway and, therefore, the optimization of the Runway Occupancy Time (ROT). Integration with en-route and terminal procedures and systems is critical to ensure predictable delivery with resilience to take account on non-nominal and abnormal events.

Performance Goals

Regarding the targets, the main Performance Goals are as following:

- Maintaining or increasing runway safety levels
- Increasing runway and airspace throughput (e.g. reducing runway occupancy time, or landing and departure wake turbulence separation) and mitigating the impact of head and cross winds plus reduced visibility
- Increase predictability (e.g. of the landing rate, of Runway Occupancy Time, runway exit and departure rotation)
- Reduction of fuel consumption, thus increasing environmental sustainability, and
- Reduction of noise in the vicinity of an airport.

3.3 PJ03a – Integrated Surface management

PJ.03a	Integrated Surface Management
Problem Statement	
Even under nominal conditions, a lack of information sharing on the surface makes pilots and airlines uncertain about the way the taxiing phase is managed and prevents them from appropriate planning. Airlines may not have a clear picture of this phase. This uncertainty and stated inaccuracies may jeopardize the whole concept of A-CDM as predictable taxi times are essential input for the efficiency and predictability of the turnaround process at the airport. Inefficient planning of movements on the airport leads to inaccuracies in the prediction of taxi times, leading to a limitation of airport capacity (available resources underutilised). During periods of increased traffic and adverse conditions, ATCOs, apron managers, flight crews and vehicle drivers workload is increased due to the lack of shared visibility of the planned and cleared taxi routes. Additionally, delays may be incurred due to the heavy use of R/T. Adverse weather conditions, reduced visibility conditions, complex and/or unfamiliar aerodrome layout can lead to taxiing operations deviating from the cleared taxi routes. This scenario incurs a number of safety related risks and potentially reduces capacity within the aerodrome taxiway system. In reduced visibility conditions and with complex aerodrome layout and/or unfamiliar crews, level of delays increases potentially resulting in reduction of the airport capacity. Under low visibility conditions, ATCOs, flight crews and vehicle drivers have to operate under block control without system assistance, which limits their situational awareness. For safety purposes, capacity is significantly reduced so as to limit the number of mobiles operating at a given time on the airport surface. Poor weather conditions have a negative impact on airport capacity and may influence safety of landings, take-off and taxi phases. In poor weather conditions, access to smaller airports can be restricted. Once the SESAR Step 1 concept of operation is implemented, an SBT/RBT will only include the airborne segments, meaning successive trajectories of a given aircraft will not be linked. When the taxi route information provided by ATC is uplinked to the aircraft it is not entered into its FMS. Predictability of gate-to-gate operations is therefore not optimal.. Predictability of gate-to-gate operations is therefore not optimal. Aircraft perform their taxi-in and taxi-out phases on engine power, which means significant fuel consumption and emissions during these phases of flight. Bad weather conditions have a negative impact on airport capacity and safety of landing, take-off and taxi phases. In bad weather conditions, access to small airports can be restricted. Due to the prevailing prioritisation of arrivals over departures brought on by a preference to delay a flight on the ground rather than in the air, an imbalanced delay distribution is likely to occur. As arrival and departure traffic peaks are frequently overlapping, approach and tower controllers are faced with managing runway movements often without an overall view of the optimum sequence. As Arrival and Departure planning systems are currently disjunctive processes in all but single mixed mode runways, they do not support decision making in terms of arrival and departure priorities, which will have a negative impact on efficiency. AMAN and DMAN systems of proximate airports do not exchange information which has a negative impact on the smoothness of the traffic flow in the surrounding airspace.	

High level solution description

In SESAR 2020 ("Step 2"), PJ03a is foreseen to work on trajectory management toward the integration of the taxi routes into the SBT/RBT by providing the two ground segments of the business trajectory. Information/Data exchange with Total Airport Management (PJ04) will be improved.

The exchange of information between ATC and vehicles/aircrafts will be improved with the use of airport datalink and other guidance means. The procedures for the surface traffic management need to be validated with the new systems.

The project is also expected to evaluate the impact on surface operations of engine-off taxiing through taxibot and wheel-mounted electric engines. Lastly, the project will investigate the integration of virtual stop bars between ATCOs and flight crews to improve safety in low visibility conditions.

PJ03a is expected to contribute to the definition and evaluation of advanced aircraft automated systems such as e.g. auto-brake and auto-taxi. The integration with future ATC surveillance systems (like artificial vision, or augmented vision) is also expected for surface operations

Finally surface management is fully integrated with arrival/departure management as well as with airport operations management (AOP/APOC) to improve reliability and predictability of taxi times and milestones and of planning information.

Work on Synthetic Vision System (SVS) concepts will also be performed to enable more efficient taxi operations in conditions of low visibility. This is applicable to all platforms and even if mainlines platforms have auto land capabilities to facilitate approaches in low visibility conditions; they have no capabilities to facilitate taxi and take in order to maintain airport capacity. Improved access into small airports in low visibility conditions shall be targeted too. The initial goal is to develop new Synthetic Vision (Head Down Display) concepts that will be used to estimate the expected benefits on airport capacity in order to provide elements for a decision gate before undertaking any prototyping development.

The graphic concepts that will be used integrate visualizations based on correlation of enhanced vision sensor and database information. This platform will be used as the basis for the BGA validation but other prototyping tools might be required for other platforms. Whilst the operational flight safety benefits are an important aspect of SVS systems, it is mainly the operational efficiency aspects that will be scrutinized in this program, e.g., landing, taxi and take-off in low RVR conditions. The EVS sensor selection activity work should be common to both the HDD and HUD solutions. The candidates for enhancement of HDD and HUD data will cover: infrared, millimetre wave radar-based and/or LIDAR enhanced vision sensor information. The work includes the definition of procedures and sensors, data bases, data link, display hardware, symbology overlay, navigation solutions, human factors concepts that will demonstrate the system value for more efficient taxi operations in conditions of low visibility

GBAS can be used as surveillance system for surface movement navigation and take-off providing an increased accuracy of aircraft position on the onboard navigation display minimising the impact of bad weather conditions on surface operations.

Development of coupled AMAN and DMAN functions at one airport considering integration of surface management constraints will address :

- Fully integrated sequence of arrivals and departures for the same runway (or for dependent runways) considering minimum separations. In a Step 2 environment the AMAN, DMAN and ASMGC-S systems at the same airport shall have full access to all SBT/ RBTs related to that airport in order for the airport to implement a complete and total runway management solution.
- High planning stability (controllers will follow TTOT and TLDT as closely as possible)
- Feeder controllers will provide the required gaps in the arrival sequence to allow for the respective departure.

AMAN and DMAN systems of proximate airports may exchange information in order to achieve a smoother traffic flow in the surrounding airspace.

Performance Goals
• Increasing predictability of operations through better trajectory management and of Takeoff and Landing Times within the planning horizon of AMAN and DMAN • Improving flight efficiency in particular under low visibility procedures • Increase flight efficiency of aircraft operations through a better balancing between arrival and departure delay • Reduce fuel emissions per flight by reducing overall arrival, surface and departure delay.

3.4 PJ03b – Airport Safety Nets

PJ.03b	Airport Safety Nets

Problem Statement

Although a number of actions have been taken in the past to reduce the number of runway incursions, prevent collisions on the apron and taxiway with traffic and fixed obstacles, there is still potential to improve safety, especially as the airport surface becomes more congested.

In SESAR 1, the following solutions have been delivered:

- Safety Alerts for controllers:
  - Alerts for conflicting ATC clearances are generated based on the ATC clearances input by the controller in the Electronic Flight Strips (e.g. one aircraft is cleared to land while another aircraft is cleared to cross the same runway);
  - Conformance monitoring alerts are generated in case of non-conformance to ATC instructions, or non-conformance to ATC procedures and aircraft state (e.g. aircraft is deviating from its cleared route).
- Runway Status Light (RWSL) system (which covers both new procedures and new airfield lights). RWSL is a surveillance driven automatic system that visually indicates to flight crews and vehicle drivers when it is unsafe to enter, use or cross a runway, through new airfield lights which can be composed of Runway Entrance Lights (REL), Take-off Hold Lights (THL) and Runway Intersection Lights (RIL);
- Traffic alerts provided by the on-board system to the flight crews (as they mainly look out the window during the airport surface operations) in case of a risk of collision with an aircraft or a ground vehicle on a runway.

High level solution description

In SESAR 2020 (“Step 2”), Project 03b will address the development of new Airport Safety support tools for pilots, vehicle drivers and controllers to avoid collisions by predicting, detecting and providing alerts for safety critical issues (e.g. risk of collision, route deviations, etc.) on the airport surface. This includes:

- Safety Alerts for controllers: the System detects potential and actual conflicting situations, incursions and non-conformance to procedures or ATC clearances, involving mobiles (and stationary traffic) on runways, taxiways and in the apron/stand/gate area as well as unauthorized / unidentified traffic;
- Two types of alerts for vehicle drivers when a potential risk of collision is imminent: traffic alerts on the manoeuvring area towards aircraft and alerting functions in case of infringement of a restricted or closed area. Initial work on vehicle driver’s alerts has achieved initial V3 level in SESAR 1 and would require further validation in SESAR2020;
- Safety Alerts for the flight crew (either generated by the on-board system or uplinked from the controller alerting system): the System detects potential and actual risk of collision with other traffic and obstacles during airport surface operations, non-compliance with airport configuration (e.g. closed runway, non-compliant taxiway, restricted area.) as well as non-conformance to procedure or clearances.
- Enhanced Airport Safety Nets through Auto-brake during Taxi phase to prevent collisions with traffic on the airport surface in situations where the flight crew is not reacting
- The Flight Crew will get assistance from the System to protect the airframe and decrease collision risk with nearby mobiles or fixed obstacles when moving on the airport surface (e.g. thanks to radar system generating alerts when the aircraft is getting close to mobiles/obstacles.

Performance Goals

- Improving safety levels at the airport for controllers, pilots and vehicle drivers

3.5 PJ04 – Total Airport Management

PJ.04	Total Airport Management
Problem Statement	

A fundamental aspect of the SESAR 1 concept has been the evolution towards a performance-based ATM system. This notion of performance management is therefore a cornerstone of the future airport concept which foresees an integrated airport management framework.

SESAR 1 focused on developing and validating:

- Collaborative planning, transcribed in the Airport Operations Plan (AOP). It is a rolling plan that interacts with a number of services (Steer Airport Performance, Monitor Airport Performance, Manage Airport Performance and Perform Post-Operations Analysis services). The AOP is the principal source of information used by all involved stakeholders, requiring individual stakeholders to make changes within their own sphere of operations. The AOP is continuously reflected in the Network Operations Plan (NOP);
- The AirPort Operations Centre capability, a multi-stakeholder organisational unit, whose main objective is to manage the AOP (Airport Operations Plan) and is the principal support to the airport decision-making process among all relevant airport stakeholders including the Network;
- The Airport Transit View (ATV) concept, connecting inbound and outbound flights in the AOP, providing a means to optimise airport operations and to enable a more efficient and cost effective deployment of operator resources;
- The Airport Demand and Capacity Balancing concept, including current procedures for balancing runway/taxiway demand and capacity;
- The de-icing management concept, oriented towards enhanced predictability of the departure process when aircraft de-icing operations apply; and
- MET data relevant for APOC (AirPort Operations Centre) processes.

During the development and validation activities in SESAR1, a number of additional support elements were identified that could not be accommodated within the scope and timeframe of SESAR 1. These elements are:

- Integrating landside/airside performance monitoring and management;
- Integrating environmental impacts into the planning and execution timeframes of the AOP;
- Defining turnaround monitoring within the APOC in coordination with Airspace Users;
- Improving weather predictability tools and impact assessment tools available to the APOC;
- Further developing the collaborative recovery procedures and support tools in coordination with ATM stakeholders (Network Manager, Airport Operators, ANSP, Airspace Users);
- Developing a Total Airport Demand and Capacity Balancing tool built upon the work achieved in SESAR 1.
- Developing a "what if" decision suite to support decision making between airport stakeholders;
- Consolidating the KPIs monitored and managed through the APOC, focusing on leading indicators of future performance thereby facilitating the pro-active management of predicted performance deteriorations; and
- Addressing Post-Operations Analysis support tools and reporting capabilities.

Following Step 1 validation and early deployment experience (review and lessons learned to be undertaken), an opportunity to review the APOC / TAM (Total Airport Management) architecture and processes can be taken to consider business reengineering and automated decision support processes to bring increased efficiency of operation.

High level solution description
In order to close out the gaps identified during the SESAR 1 programme, the following elements of work need to be addressed: • **Integration of landside/airside performance monitoring and management**: the APOC concept described in SESAR 1 includes three main activity flows through the airport, i.e. aircraft, passengers and baggage flows. Traditionally these three flows have been considered in 'isolation' whereas the Total Airport Management approach considers the impact that the landside (passenger and baggage) processes have on the aircraft process. So whilst this project will not perform specific research into the landside elements (considered out of the scope of SESAR), it will consider how the 'knowledge' of the current and predicted performance of these processes can be used to improve specifically the predictability of the aircraft process. This includes the development and validation of monitoring and decision support tools to manage airport performance, in particular to further improve the predictability and efficiency of the aircraft flow and hence the departure of the aircraft from the airport and into the Network. • Include **environmental impact in the planning and execution timeframe**. Environmental KPIs have been described within the Airport Steering and Monitoring services, and some environmental aspects have been accommodated within the Runway Demand and Capacity Balancing tool. It is acknowledged that environmental KPIs are critical to an airport's relationship with its community and hence its ability to grow. As a result, it is felt that more work is required to embed environmental impact aspects into the AOP planning and execution processes, including the development of a decision support tool that accommodates environmental impacts. In that respect the work done on environmental aspects in SESAR 1 should be taken on board. • Although the turnaround of an airframe is under the control of Airspace Users, it is acknowledged that by monitoring key aspects of the turnaround process the APOC would get an early warning indicator of possible delay. Further development needs to be done in association with Airspace Users in regards to defining a suitable level of **Turnaround Process Monitoring within the APOC.** Together with the User Driven Priority Process (UDPP) project, this area of development aims to improve the advanced communication and pro-active management processes between Airspace Users and the APOC. • **Weather predictability** is critical to the pro-active management of meteorological impacts on the AOP. Development of a decision support tool that allows the APOC to assess the impact of the variable probabilities (likelihood) of the occurrence of key meteorological conditions and a combination of meteorological conditions needs to be developed • The SESAR1 APOC description includes APOC activities for the recovery from adverse conditions. These **collaborative recovery procedures** inclusive of affected ATM stakeholders require further validation and technology support in order to make the process manageable on a large scale to accommodate a large number of participating Airspace Users. This includes the need for the Network Manager to be able to first coordinate with a single airport and in a second stage with a large number of airports as it may be the case in a Massive Diversion situation, to reduce knock-on effect and optimise solutions, ensuring that users' end-to-end processes are managed. • Develop a '**What-if' decision support suite** that accommodates all the key performance flows of the airport, i.e. passenger, baggage and aircraft flows plus environmental and meteorological impacts, allowing trade-offs between KPAs and efficient support to decision-making between airport stakeholders. • **Consolidate/integrate the KPI suite** ensuring coverage of both landside and airside operations and focusing on leading performance indicators to support pro-active management of arising situations. The KPI suite should incorporate and align with the Airport relevant **Reference Period (RP)** metrics (RP2 addresses the period 2015-2019) and a dashboard needs to be established to rationalise the airport performance framework. • A continuous balance between Demand and Capacity within all operational areas of the airport has to be achieved. Building on the Runway DCB Tool developed within SESAR 1 and the specific topic areas development above a **Total Airport Demand and Capacity Balancing** tool needs to be developed. This tool should be able to predict DCB imbalances with immediate affect or in the future, identify where the imbalance occurs (e.g. Terminal 2 stands or Northern area

taxiway) and also be useable as a 'What-if' decision support tool. • Further extend the **Post-Operations Analysis** concept including development of support tools for the timely analysis of specific events and reporting to support a continuous learning environment.
Performance Goals

The following primary performance improvements are expected:
• A performance-driven airport through KPIs monitoring and detection of deviations, collaborative decisions using support tools and what-if functions, post-operations analysis used as learning process.
• Better situation awareness through SWIM information sharing, enabling provision and reception of Airport CDM data including MET/AIS.
• An increase in the predictability and flexibility of airport operations;
• An increase in the efficiency in airport operations
• Better use of existing airport capacity;
  ○ Proactive management of predicted impacts to normal operations, quicker reactions on deviations.
  ○ Increased resilience through shorter and effective recovery to normal operations and collaboration with the Network, from predicted or unpredicted adverse operating conditions;
• Increased safety in the airport environment due to reduced uncertainty of operations and reduced congestion through better planning; and
• Improved environmental sustainability due to reduced emissions on the ground through more efficient airport operations.

3.6 PJ05 – Remote Tower for Multiple Airports

PJ.05	Remote Tower For Multiple Airports

Problem Statement

The costs for performing ATS, and apron control are high and need to be reduced / limited, particularly at low to medium density airports.

- The maintenance and upkeep of old Tower facilities is inefficient and expensive.
- The relative cost of ATS is high due to inefficient use of ATS personnel compared to the ATS tasks that have to be performed.
- Society demands on accessibility of transport vs. the related cost.

The effect of an ATC tower unit being closed down at an aerodrome, controlled or un-controlled (e.g. maintenance or crisis) must be managed.

- Contingency solutions for ATC or other related services at airports are costly and inefficient
- The alternative cost of closing and/or insurance costs against closing an aerodrome may be very high for the airport owner in today's operations (e.g. claims due to unavailability of contracted slot allocations).

High level solution description

Multiple remote tower

The Remote Tower operational concept enables the cost effective provision of Air Traffic Services (ATS) or other related services (apron/ground services etc.) at several airports at a time by one controller from a control facility that is not located in the local ATS Tower.

The required level of safety and the required capacity at each of the remotely controlled airports will be met.

Based on the results of SESAR 1 the multiple remote concepts needs to be validated for different environments in order to demonstrate how many airports with how much traffic at a time can be controlled. Different combinations of very small, small and medium size airports might be controlled at a time.

Multiple Remote Tower requires development of the Controller Working Position (CWP) to enable one controller to provide ATS to several airports at a time. Using unified CWPs can lower maintenance costs and support time efficient on the job training (OJT). Integration of airport CWP developments shall be considered.

As maintaining situation awareness becomes an increasingly important factor with multiple remote tower operations, additional automation functionalities should be developed in order to gradually increase the operating range of the concept. Automation functionalities can cover for example voice recognition, alerting and warnings for conflict detection and conflict resolution advisories.

In some environments the need for an improved surveillance might occur, which requires a seamless integration of air/ground multi-sensor tracking.

Situating the multiple remote tower providing ATS in a Remote Tower Centre, RTC ensures possibilities for a more cost efficient solution e.g. through flexible use of human resources.

The need for the role of an RTC Supervisor and supporting systems will be defined.

In some environments an integration of approach (APP) for airports connected to the remote centre need to be investigated as an enabler for efficient use of ATS personnel.

Human Performance (HP) aspects in the working environment will be addressed on case by case basis as well as operational impacts due to technical solutions e.g. Out The Window screens (OTW).

The situational awareness in the safety context needs to be assessed in the multiple environments. Interoperability aspects regarding cross border operations are to be addressed for the possibility to develop systems working beyond borders.

Contingency remote tower

The remote tower operations in contingency solutions ensure that ATS can maintain a high level of capacity in cases when normal tower operations are not available. In contrast to single remote tower operations (SDM-201) in contingency operations a high traffic volume needs to be controlled (not necessarily by just one controller as usually implemented for single remote tower.

Some of the elements of the contingency tower might also be transferred into the physical local tower in some environments (e.g. surveillance of remote areas). These spin-off elements will also be investigated as they have potential to increase cost-efficiency in some large towers and other related surveillance tasks at airports, (e.g. apron or ground).

Performance Goals

Increase Cost-Effectiveness ensuring Safety levels are maintained. Corresponding validation targets are:

- Safety

  Safety (and security) levels are sufficient for the tasks being performed from the remote location. Any issues regarding degradation of Human Performance are either mitigated by adjusted procedures or new system functionalities

- Cost Effectiveness
  Better cost effectiveness can be reached through large scale operation with co-location of staff, management, training, etc.
- Capacity
  The level of requested airspace and runway capacity for the target candidate environments can be provided by the Remote Provision of ATS under normal conditions

3.7 PJ06 - Trajectory & Performance Based Free Routing

PJ.06	Trajectory & Performance Based Free Routing

Problem Statement

Free routing corresponds to the ability of the airspace user to plan and re-plan a route according to the user-defined segments within significant blocks of Free Route Airspace (i.e. multiple FIR AOIs (areas of interest) or FABs) where airspace reservations are managed in accordance with AFUA principles. Free Routing User defined segments are segments of a great circle connecting any combination of two user-defined or published waypoints.

The Free Route concept may be deployed:

- Through Free Routing Airspace (FRA), which is an Airspace defined laterally and vertically, allowing Free routing with a set of entry/exit features.
- Or, as an interim Step towards Free Routing implementation, through the use of Direct Routing Airspace, which is an airspace defined laterally and vertically with a set of entry/exit conditions where published direct routings are available.

The following Free Route improvements are part of the ATM Master Plan

- Step 1:
  - : Direct routing concept across ACC borders and in high & very high complexity environments.
  - Free Routing in low to medium complexity environment
- Step 2:
  - Free Routing in high and very high complexity environment

Within SESAR 1, subject to the result of the validations, the Step 1 improvements should have been V3 validated in order to allow, at a large geographical scale, the deployment of:

- The Direct Routing concept in high and very high complexity environment
- And the Free Routing concept in low to medium complexity environment.

Moreover, some of the Network Management activities in the scope of SESAR 1 (e.g. ASM and FUA, DCB…) related to the implementation of Free Routing in high and very high complexity environment should have also been V1/V2 validated.

Nevertheless, some additional validation activities are required to allow the deployment of the Free Routing concept in high and very high complexity environment, which corresponds to the targeted implementation of the Free Routing concept.

These activities will be carried out within SESAR 2020 scope.

High level solution description

SESAR 2020 activities will focus on validating Free Routing operations for Flights both in cruise and vertically evolving within high & very high-complexity environments.

Free Routing corresponds to the ability of the airspace user to plan and re-plan a route according to the user-defined segments within significant blocks of Free Route Airspace (i.e. multiple FIR AORs (areas of interest) or FABs) where airspace reservations are managed in accordance with A-FUA principles. User-defined segments are segments of a great circle connecting any combination of two user-defined or published waypoints, within high & very high-complexity environments.

To realise the objective of the airspace user to plan flight trajectories without reference to a fixed route network or published directs within high & very high-complexity environments. Additional infrastructure is required locally and regionally to establish Free Routing Airspace. Controller workload associated with individual trajectory interactions is anticipated to increase within a non-published route airspace environment, as a result free routing within high & very high complexity environments is likely to require a full advanced controller tool set, highly modular airspace (to match configuration with forecast demand) as well as full SWIM functionality. Demand & Capacity Balancing in both the planning and execution phases will have to evolve to manage the more dynamic environment including INAP and AMC (balancing Military & Civil airspace needs) processes.

In realising this objective airspace users' ability to plan trajectories, without reference to a fixed route or published direct route network (within high to very high complexity environments), will provide them with significant opportunities to optimise their associated flights in line with individual operator business needs and military requirements.

Free Route OI Steps describe the evolution of an operating environment to a new state, and thus cover very transversal areas of concept. Therefore PJ06 will be working in close coordination with all the projects listed below (cf. dependencies section). The concept elements descriptions, the validations roadmaps will require being deeply coordinated. PJ06 will perform integrated validations.

The following concept elements will be considered in the Step 2 Free Routing environment:

- Flight plan taking into account weather conditions (using adapted tools with more MET info))
- Flight Planning processes at both AU level and Network level
- Airspace Organisation and Management, including AFUA. ARES (incl. DMA) circum navigation procedures in the execution phase
- ATFCM processes
    - Hot-spot monitoring and Complexity assessment
    - Airspace organisation (Dynamic Airspace Configuration (through elementary building blocks and DMA))
    - DCB measures implementation (incl. management of 4D constraints)
    - Possibility (or not) to anticipate weather impact on trajectory
- Separation management (using enhanced CDRT (Conflict Detection & Resolution Tools, and RNP capability) and inter ATSU coordination procedures
- Adverse weather circum navigation in the execution phase
- Ground based safety nets (APW adapted to DMA)

The project also includes the definition of technical specification and development of supporting system(s) for the future FOC, its verification and integration with SWIM Infrastructure allowing all Airspace Users to plan and execute the most efficient Business/Mission Trajectory in line with performance requirements. The FOC must be able to consider the Free Routing configuration information, the location and availability of Free Route areas and the rules for the transition from one network type to another will have direct influence on the trajectory generation process at FOC.

Performance Goals

“Trajectory & Performance based Free Routing” objectives includes:

- Maintain Predictability
- Improved Environmental Sustainability / Flight Efficiency
- En Route Capacity maintained or improved
- Safety maintained or improved

3.8 PJ07 – Optimised Airspace Users Operations (UDPP)

PJ.07	Optimised Airspace Users Operations (UDPP)
Problem Statement	

Airspace Users in Long-term planning phase perform a scheduling process during which all assets required for the flight are prepared. This schedule has an intrinsic priority as it optimally reflects business criteria. When the schedule gets disturbed in Medium-Short term planning phase, in particular by a demand-capacity imbalance generating delays, potentially leading to cancellations, the intrinsic priorities change.

It is estimated that irregular operations can cost between 2 and 3% of airline annual revenue and that a better recovery process could result in significant cost reductions of its irregular operations.

From an Airspace Users' point of view, not all flights are equal in terms of schedule priority. Before SESAR1 Airspace Users had limited flexibility to react to disrupted situations, and decide (or at least indicate) which flights they would like to get least/most impacted by the demand capacity imbalance in order to reduce the impact on Airspace Users' costs, regularity, punctuality and connections.

When operations are disrupted, the User Driven Prioritisation Process (UDPP) aims to provide Airspace Users with increased flexibility for keeping their business driven schedule priorities on track, through a Collaborative Decision Making (CDM) process between Airspace Users (FOC) and ATM stakeholders (ANSP, Airports, Network Manager).

SESAR1 brought significant improvements:

- Airport and Network solutions developed within SESAR1, alongside with the increased sharing of operational data (enhanced Flight Plan, SBT/SMT, AOP, NOP) resulted in operational decisions being made with a more accurate picture of the true demand.

  - Early identification of DCB imbalances
  - Collaboratively managing DCB imbalances
  - Fine tuning response/recovery scenarios in order to minimise the number of trajectories that need to be adjusted

This has shown a reduction in the number of ATM regulations (CTOTs) being applied at a number of major European Airports.

- UDPP short-term improvements allow Airspace Users to react to delays by swapping or reordering their flights (achievements Step1 with a V3 maturity level):

  - On departure at a given A-CDM Airport, the Airspace Users' prioritisation demands are taken into account and processed into the pre-departure sequence.
  - For en-route and arrival delays, currently managed through ATFM regulations, the existing ATFM slot-swap has been extended, thus providing a wider range of possibilities

An initial UDPP concept for prioritisation (Step2) has been elaborated whereby Airspace Users could identify priority flights and collaboratively manage their demand profile to support their business needs, and initial validation has been performed.

The full integration of AUs business needs into the ATM network processes still needs R&D and validation activities to be performed in SESAR 2020.

High level solution description

UDPP in SESAR 2020 will complete the concept definition of the prioritisation capabilities allowing those Airspace Users (AUs) participating on a voluntary basis, to pro-actively prepare mitigation strategies in face of Performance degradation (due to ATM Network, Airports or AU operations), as early in the Medium-term planning, as well as fine-tuning swapping/reordering in the Short-term planning phase.

Prioritisation capabilities for re-planning during Execution will also be considered and further investigated.

Based on the achievements in SESAR1, the following elements are considered necessary and will be developed for pre-deployment:

Concept elements:

- Prioritisation on Departure (integration with DMAN) (beyond Step1 swapping/reordering)
- Integration of ICAO/FF-ICE-1 Fleet prioritisation in UDPP processes
- UDPP on Arrival (integration with AMAN, XMAN) (may partially start in SESAR1)
- UDPP-DCB integration (multiple constraints management, preferences)
- UDPP integration with A-CDM processes
- UDPP for Re-planning during Execution
- UDPP for ad-hoc cases (e.g. non-scheduled operations)
- Performance indicators for Airspace Users (in addition to PIs for Airports and ANSPs)

Development for validation activities:

- UDPP tools integrated in the AOP-NOP – refinement to V3 maturity
- UDPP recordings (distributed database in the NOP)
- UDPP-Airport prototype
- UDPP-AU prototype
- UDPP-Network prototype
- UDPP-ANSP prototype

Research themes aiming at improving the quality of service:

- Develop technology that minimises or eliminates the need for Airspace Users to intervene (high level of automation)
- New working methods - Impact of increased flexibility on AUs Operations: change of practices, new strategies, business impact
- Modelling of AUs strategies for performance assessment and improvement (Agent Based modelling?)
- Market-based incentive mechanisms and UDPP: Best Equipped Best Served (BEBS) , route charges, etc

Enablers :

- Trajectory Management: from SBT to RBT revision
- SWIM related aspects for information sharing
- MET information for stakeholders involved in UDPP : de-icing process, forecasting (from 3 days to 2 hours before departure), now-casting on arrival airports
- Safety

The project will also include the definition of technical specification and development of supporting system(s) for the future FOC, its verification and integration with SWIM Infrastructure allowing all Airspace Users to plan and execute the most efficient Business/Mission Trajectory in line with performance requirements. The FOC must be able to consider the UDPP process outputs that might have direct impact on the trajectory generation process.

Performance Goals

The main performance objectives of UDPP include:

- Increased flexibility by allowing the Airspace Users to recommend to the Network Management function a priority order for flights affected by delays – leading to increased Cost-Effectiveness through the reduction of direct & indirect costs to Airspace Users
- Increased punctuality and predictability of individual flights
- Equity is a condition for UDPP to be successful
- No negative impact on capacity, safety, environmental efficiency for network/airport performance

3.9 PJ08 – Advanced Airspace Management

PJ.08	Advanced Airspace Management
Problem Statement	
Today, Air Traffic Flow management, Airspace Management (ASM) and ATS are separated processes even though the coordination between all in Step 1 is significantly improved through interfacing between ASM, ATFCM and ATS systems. With step 1 solutions, full collaboration between ASM, ATFCM, Airspace Users and ATS Actors does not take place, constrained by the available technology / limited tools e.g. e-mails, meetings, videoconference, e-conferencing and limited information causing a lack of situational awareness. The current ATM environment and Step 1 solutions does not provide for a firm, confident, prediction of the traffic with which to determine appropriate required Airspace Design and efficient Flexible Use of Airspace (military and civil coordination). Also the information share of flexible airspace is not adapted to airlines processes, which is leading to limited usage of dynamic available airspace. Thus, baseline airspace sharing and organisation, and associated resources (controller deployment, ARES for military activities …), are selected according to the information available on emerging traffic demand. Similarly, the current ATM environment does not provide accurate prediction of the traffic and uncertainty on it, and sector predicted workload with a confidence index with which to determine efficient airspace organisation. The aim of the document is to describe the AAM concept development and validation activities in the scope of SESAR 2020. Most of step 2 concepts and validations planned in SESAR 1 will be pursued in SESAR 2020 to extend well past 2016 to tackle V3 validation exercises (RTS, possibly live-trial). Step 3 concepts and validation will be initiated and developed until V2 maturity level.	
High level solution description	
Dynamic Airspace Configuration is enabled, via the incorporation of Complexity Management and efficient traffic forecast and uncertainty into the DCB process with the intention of allowing for the opportunity to provide an automated support mechanism, to optimise airspace configuration based on “Predicted Workload”. Airspace configuration is fully integrated in DCB processes for all phases at local, sub-regional and regional levels. That means that the processes of elaborating airspace configuration include DCB assessment and, vice versa, in case of any DCB issue, airspace (re)configuration is one amongst the possible means to solve imbalances, and it will be initiated by the DCB function. In long term planning, Flexible Airspace is designed to predict needed resources (ATCOs) to fulfil the forecast AUs demand according to the uncertainty on this demand and the confidence index calculated on the resulting Airspace organisation. According to this Airspace organisation confidence index, decisions can be taken to face the forecast demand. In terms of coordinated Military Airspace demand, Dynamic Mobile Areas (DMA) are temporary mobile airspace exclusion areas, which aim is to minimise the impact on the network while satisfying the needs of military airspace users. Three types of DMAs are identified: DMAs of types 1, 2 and 3. This project will continue the validation of DMA type-2 and encompass the DMA of type 3. A DMA of type 3 is an area with defined lateral and vertical dimensions around moving activities requiring extra lateral and vertical separation from other trajectories. A DMA of type 3 is therefore a defined volume of airspace (”bubble") moving with the aircraft to be separated from the rest of the traffic. These DMAs can be used both in a free route environment and in a fixed route environment. To fulfil the AUs demand, ATC sectors shape and volumes are adapted in real-time to respond to dynamic changes in traffic patterns and/or short term changes in environment and users' intentions. Dynamic Sectorisation offers additional options in situations where the usual structure is reduced and typical patterns do not work, the objective being to handle not only recurrent traffic but also unpredictable changes in traffic demand (e.g. due to sudden weather problems, system outages). ATM Airspace resources (including airspace and ground resources) management efficiency will be developed by contributing to the Network Operations Plan (NOP) to make it as optimised and stable as	

possible (in both the long, and medium to short term phases), using the latest known traffic prediction and Predicted Workload information.

Network and ATM performance will be improved through a seamless integration of Airspace Management functions into the DCB process and enhanced system prediction capability and confidence index.

Efficiency will be delivered through the reduction of demand/capacity imbalances by increasing the ability to adjust the Capacity part, which reduces the deviation of AU selected optimal 4D flight profiles. The precise adjustment of the NOP should lead to the balance between Demand and Capacity to the highest level of efficiency, thus increasing the decision-making capability of the concerned actors.

Anticipation will enable both the identification of situations where the traffic complexity (Workload Prediction – is not part of this project) in a specific area is out of equilibrium or out of proportion as regards other directly related areas, as well as the assessment of impact on airspace capacity, predictability, flexibility, fuel efficiency, and safety. This information will lead to the development of new associated functionalities to assess Dynamic Airspace Management and Resource Allocation measures (e.g. dynamic sector configuration, DMA allocation), and Traffic Management measures (e.g. re-routing, level capping) with the final objective of solving complexity problems.

Activities will be carried out through various functions performed at Regional, Sub-regional, and Local levels (ANSPs, FABs, NM), all contributing towards the delivery of a seamless process where the macro-optimum solution will generally be chosen in favour of the micro-optimum.

The efficiency of the implemented initiatives will be monitored and compared with the targets assigned as part of the ATM Performance framework. These targets will be integrated to the DCB/DAC system to be managed in real time, driving solutions to DCB imbalances.

The implementation of "Advanced Airspace Management" will deliver following improvements:

- Better resource prediction. Anticipation of needed ATCOs resources is a key issue for ANSPs to optimise cost. Accurate long term planning directly drive the ability to put in place anticipated Airspace organisation face to traffic forecast and gives the level of accuracy (confidence index) of this anticipation.
- Better use of resources. Smoothing of ATCOs resources by Airspace organisation is an efficient mean to save ATC resources without touching AUs demand. AAM manages resources in optimum way driven by constraints on results.
- As result of above – positive impact on the cost effectiveness is expected even when/if air traffic and ATCO workload may increase
- Higher ability to propose adequate Airspace organisation without touching AUs demand. Due to the increase of possible solution in term of Airspace organisation and because Capacity is the first step of the DCB process, the number of possible solution face to traffic forecast is increased. The need of a tool to manage and propose Airspace solution is absolutely necessary face to the huge number of possible combinations of Airspace components.
- Anticipated Airspace Solution publication. Publication of coordinated Airspace plan between Civil and military through AAM, allow robust and coordinated Airspace solution. This solution is published and AUs can anticipate solution in case of necessary AUs demand modification.
- Short term reactivity in term of Airspace reorganisation. Efficient AAM support tools allow rapid reaction face to changes. This allow rapid Airspace reorganisation based on constraints results (Number of ATCOs,)
- Adaptable to local rules and specificities. AAM integrates large panel of data configuration allowing local adaptation to any rules, delegations and environment.
- The possibility to assess DAC solutions at local, sub-regional and regional levels

Performance Goals

- Capacity: Advanced Airspace Management allows a better use of available ATC capacity and a better balancing of ATC workload leading to reduced demand/capacity imbalance.
- Cost-effectiveness/ Cost of Air Navigation: Advanced Airspace Management allows improved ATM resource planning and better use of existing capacities leading to reduced ATC and Airport Capacity costs.
- Flight Efficiency: Advanced Airspace Management should increase Airspace Users fuel consumption and reduce flight time.
- Environment: Increased efficiency enabling optimised flight trajectories and profiles with the end result being reduced fuel burn, noise and CO2 emissions

- Flexibility: Advanced Airspace Management allows increasing the flexibility of airspace configurations to adapt to any change of demand pattern or unexpected change of users trajectory intents.
- Participation: Advanced Airspace Management enabled by SWIM/NOP should enable stakeholders' collaborations earlier in the planning phase and facilitate commitment to network performance optimum by making stakeholders' intentions and actions more transparent.
- Cost-effectiveness/ Direct cost of NM: Advanced Airspace Management supported by SWIM/NOP Information Platform will contribute to reduce maintenance and development costs for the Network Manager and local service providers by reducing the number of different remote HMI applications (through implementation of one stop shop access) and by streamlining assets through use of uniform service-oriented principles.
- Safety: Advanced Airspace Management should ensure that safety standards will no be downgraded enabled by automated support tools and may be improved through an increased common situational awareness at sub-regional and regional levels.

3.10 PJ09 – Advanced Demand Capacity Balancing

PJ.09	Advanced Demand and Capacity Balancing
Problem Statement	

SESAR 1 developments in the context of network operations have resulted in improvements in predictability and reliability of planning data thereby reducing the ATM capacity held in reserve for exceptional demand capacity imbalance scenarios. Short Term ATFCM processes have further improved the flexibility of the Network Manager to tactically manage imbalances in the Network. This has shown a reduction in the application of 'broad brush' constraints and regulations.

The Network Manager has developed the first step of a Collaborative NOP with initial integration of ATM stakeholders' processes and Airport Operations Plans (AOPs). At the completion of SESAR 1, the collaborative NOP is a powerful tool to assist medium-short term DCB planning processes. However, the operational data shared in the NOP is still limited (in scope and time horizon), incomplete and insufficient (wrt update rate, accuracy, liability) for tactical and operational use. Information regarding Dynamic Airspace Configuration and Airports is limited not systematically integrated in the NOP. Information regarding Military operations is subject to operational constraints and the ATM and military networks are not fully integrated. The operational data is not yet reflecting a unique set of real time data to support tactical DCB processes, collaborative decision making and network performance monitoring in the execution phase.

System capacity is impacted by insufficient anticipation and flexibility in the short term DCB phase and the lack of ATC participation in the process execution. This rigidity is aggravated by the absence of a single seamless DCB management process that involves airport, terminal and en-route nodes and by the lack of automated tools that provide relevant indicators to assess DCB measures and monitor execution against the impact on network performance.

Building on the SESAR 1 work, further development needs to be done to improve/expand the dynamic sharing of operational data, to enable tailored real time network performance assessment and to facilitate collaborative DCB processes. Due to technology development timelines and the heavy change load experienced on the Network Manager function within the SESAR 1 timeframe, the full automation of the DCB management processes will not be achieved.

Further development of automated tools, monitoring relevant indicators to assess DCB measures and monitor execution against plans will allow seamless DCB management processes involving Airspace Users, alongside Airport and en-route nodes.

This will permit a proactive identification of constrained points in the Network and the application of collaborative procedures to address the situation with the least number of trajectory changes as possible.

High level solution description

<u>Collaborative NOP</u>

The Network Manager shall implement a Collaborative NOP fully integrated in ATM stakeholders' planning processes and working methods, including airport operations planning (AOPs).

The Collaborative NOP shall be updated through real time data exchanges between Network Manager and operational stakeholder systems in order to cover the entire trajectory lifecycle for monitoring and assessing network performance and following-up stakeholders' actions and compliance with agreements. Airport constraints and weather and airspace information shall be systematically integrated into the NOP. Where available, the airport constraints shall be derived from the AOP and the collaborative management processes defined in the APOC implementation.

The development of the next evolution step for the Collaborative NOP shall focus on:

- The systematic availability of shared operational data updated in real-time, and refined throughout the planning cycle up to and including execution;
- The provision of a rolling picture (from strategic to tactical) of the network situation (incl. dynamic airspace configurations, predicted demand and constraints) used by stakeholders to prepare their plans and their inputs to the network CDM processes;
- The implementation of access authorisation mechanisms with layers of security for so that only

those who have an operational need to access particular information are able to do so;

- The availability of query mechanisms and what-if functionalities to provide all operational stakeholders with operational information to support their needs (e.g. SBT planning, DCB decision making and approval processes);
- The implementation of common standard interfaces between operational stakeholders (including the AOP systems) and network management systems using SWIM services once available;
- The monitoring of the quality of NOP information (e.g. accuracy, consistency, completeness);

Advanced DCB

The main solutions proposed by the "Advanced DCB processes" can be loosely structured into two items that will deliver the expected benefits: Improving the ATM resource management efficiency and reducing the impact of complexity imbalances on capacity through their anticipation.

ATM resource (including airspace and ground resources) management efficiency will be developed by contributing the Network Operations Plan (NOP) towards an optimum with managed stability (in both the long, and medium to short term phases), using the latest known traffic and complexity/workload information. Network performance will be improved through a seamless integration of Airspace Management functions and Dynamic Airspace Configurations (DAC) into the DCB process and enhanced system prediction capability. Efficiency will be delivered through the reduction of demand/capacity imbalances to reduce the deviation of AU selected optimal 4D flight profiles. The precise adjustment of the NOP should lead to the balance between Demand and Capacity to the highest level of efficiency, thus increasing the decision-making capability of the concerned actors.

Anticipation will enable both the identification of situations where the traffic complexity in a specific area is out of equilibrium or out of proportion as regards other directly related areas, as well as the assessment of impact on airspace capacity, predictability, flexibility and safety. Prediction of DCB constraints and complexity issues will be based on the definition of metrics and algorithms for prediction, detection and assessment of traffic complexity. This information will lead to the development of new associated functionalities to assess Dynamic Airspace Management and Resource Allocation measures (e.g. dynamic sector configuration, DMA allocation), and Traffic Management measures (e.g. re-routing, level capping) with the final objective of solving hotspots and complexity problems. This will include the definition and refinement of associated processes, roles, responsibilities, functionalities and information exchanges required to perform Demand Capacity Balancing activities.

Activities will be carried out through various functions performed at Regional, Sub-regional, and Local levels, all contributing towards the delivery of a seamless process where the macro-optimum solution will generally be chosen in favour of the micro-optimum.

The efficiency of the implemented initiatives will be monitored and compared with the targets assigned as part of the ATM Performance framework. All parties involved, NM, ATC, Airport, Flight Operations Centre (FOC) and the Flight deck will play an active role in the execution and facilitation of the Network operations plan and the implemented initiatives. In particular, The FOC must be able to consider 4D constraints and generate the trajectories that will be used through the DCB processes. The NOP will be the main source of input parameter for the generation of the trajectory (constraints, airspace information etc.) and the FOC will share these trajectories through the NOP. Tactical feedback and post ops analysis will be provided where the outcome of a tactical solution differs from one that was expected.

The implementation of "advanced DCB processes" will deliver enhancements to the development of DCB in the planning phase, dynamic DCB and Complexity Management processes and systems integrating more advanced concepts such as:

- Improved interoperability between AUs and Network Manager allowing the exchange of flight profile data among all stakeholders.
- Improved traffic predictability thanks to an assessment method and related indicators in support of the traffic demand enrichment.
- Improved predictability of sector Capacities: through increased awareness and reliability of traffic and workload predictions.
- Improved predictability and situation awareness through the use of MET phenomena forecast in DCB & dynamic DCB processes;
- Improved cost-effectiveness through more effective resource planning and better capacity exploitation enabled by integrated Airspace Management with DCB and the increased
- Accuracy and reliability of shared data and demand capacity predictions.

- Reconciliation of DCB measures with ATC (AMAN, XMAN) and Airport (Airport CDM, Departure Management).
- Short-Term ATFCM Measures (STAM) support the dynamic coordination between more than one ACC, AUs, and the Network Manager. STAM closes the gap between ATC and DCB taking place a few hours and a few minutes before entry into the sector. STAM are used to solve hotspots and complexity issues through a seamless ATM layered planning process, which ensure that those solutions are compatible and efficient with traffic synchronisation activities and strategic conflict management under the responsibility of the ATC planning function.
- Target Times of Arrivals (TTAs) with adequate tolerance levels are generated for all fights, in order to ensure optimum utilisation of available capacity. Arrival planning is facilitated because aircraft reach the TMA at the time that was planned at network level, which reduces arrival delay and the need for holding.

Performance Goals

- Cost-effectiveness/ Cost of Air Navigation: Demand Capacity Balancing allows improved ATM resource planning and better use of existing capacities leading to reduced ATC and Airport Capacity costs.
- Safety: Smooth peak demand & reduce complexity allowing the capacity to be used more consistently and Improved safety in better anticipating and managing potential overloads.
- Increased efficiency enabling optimised flight trajectories and profiles with the end result being reduced fuel burn, noise and CO2 emissions
- Improve the predictability in:
  - The NOP will provide the planned network situation considering all known constraints. The NOP will contain the reference network plan, as well as the latest, most accurate information relating to the Network Situation status (incl. residual hotspots), thus enabling airspace users to take informed flight planning decisions. The NOP will contribute to maintain block-to-block and arrival performance. It will also help preventing and mitigating service disruption, contribute to reduce recovery times and help stakeholders to restore the plan.
  - managing time deviation by anticipating demand/capacity imbalance detection and improving the implementation of solutions as well as managing time accuracy at CTA/CTO
- Flexibility: The NOP will give the common awareness to all stakeholders (incl. non-scheduled flights) and provide updates resulting from late changes to demand, capacities and influencers (weather, etc.). The NOP will provide access to opportunities in case of late changes in capacity or demand.
- Participation: The NOP should enable stakeholders' collaborations earlier in the planning phase and facilitate commitment to network performance optimum by making stakeholders' intentions and actions more transparent.
- Cost-effectiveness/ Direct cost of NM: The Collaborative NOP Information Platform will contribute to reduce maintenance and development costs of the Network Manager by reducing the number of different remote HMI applications (through implementation of one stop shop access) and by streamlining assets through use of uniform service-oriented principles.

3.11 PJ10a – Separation Management En-Route

PJ.10a	Separation Management En-Route

Problem Statement

The current operation within En - route airspace is highly tactical with the use of multiple radar vectors and stepped climbs and descents to maintain separation between aircraft in high traffic situations. This leads to less efficient flight profiles and high levels of workload for both ATC and the flight crews. Additionally, these less efficient profiles increase the amount of fuel uploaded. It makes it also very difficult to balance the operators' requirements in terms of flight efficiency (notably user-preferred trajectories) with the need for overall capacity, safety of the operations and ATC workload.

Occasionally, where no further splitting of sectors is possible due to limited controller resources, the sector demand exceeds the available controller capacity resulting in flow restrictions, level-capping and other measures that ensure safety at the expense of flight efficiency and timeliness.

Future En-Route environment is anticipated to be even more loaded and complex, and substantially different from today, as full business and mission trajectories will be used.

There is a need for improved separation provision and sector management En-Route where real free route and mixed mode operations based on RNAV and RNP specifications are implemented. Thus new enhanced ATC tools and the development of new concepts are required, to allow for different controller team structures to suit various airspace structures like free route, various traffic levels and complexities.

The separation management concepts developed in SESAR1 have, in some cases, required development of an underlying trajectory prediction capability to generate the trajectories required to support conflict detection, conformance monitoring and sector team roles. These Trajectory Prediction (TP) requirements are independent of the RBT and the trajectories are built locally (i.e. are not shared) to support the specific use in the required ATC tool. TP requirements produced in SESAR 1 include:

- Building of separate trajectories to support the various planning and tactical tasks
- Building of speculative trajectories to support "What-If" functions
- Incorporation of AOC data together with EPP (Extended Projected Profile) and DAPs into ground-based trajectories
- Use of trajectory information such as uncertainty.

High level solution description

Depending achieved maturity level in SESAR 1 and depending on the operational environment different numbers of iterations of development and validations cycles will be necessary.

The objective is to propose strategies and approaches so that in future environments (including free-route) the ATCOs can manage separation in a safe, orderly and expeditious way. This encompasses:

- Enhancement of current assistance tools through an improvement of their performances, e.g.
    - Enhanced ground TP
    - Shared information
    - EPP
    - Integration of ASM and mission trajectory data
- Addition of new functionalities, e.g.:
    - Automatic detection of conflicts
    - What If, What Else probing
    - Civil/military coordination
    - Block level conflict detection to support cruise climb
    - Profile constraints
    - Removal of boundary co-ordinations

- Validation of new separation aids by providing new ATC support tools for En-Route environment, e.g.:
    - CD & CR tools
    - autonomous conflict resolution tools
    - Conformance and Intent Monitoring
- Validation of new sector team organizations and responsibilities distribution together with associated assistance tools in order to provide a more strategic environment to optimise flight profiles, minimise delays, increase ANSP cost efficiencies.
- Validation of the integration of new ATC separation management functionalities where applicable
- Quantification of the value provided by RNP specifications (as defined in the ICAO PBN Manual) to radar separation minima

It is expected that the ground-based trajectories will include the incorporation of increasing amounts of airborne data and data from other sources.

Another objective is to study, for more specific circumstances, the ASAS Separation (cooperative separation) mode, for which the controller delegates separation responsibility with respect to the dedicated traffic and transfers the corresponding separation tasks to the flight crew supported by automation.

The key applications for study will be "In-trail Follow", which allows aircraft to maintain reduced longitudinal separation at the same flight level, and "In-trail Merge", which allows aircraft to join parallel tracks at substantially reduced longitudinal separation, possible to be started in oceanic airspace or airspaces with low traffic density.

Pairwise Trajectory Management (PTM) concept/capability currently being developed by RTCA/EUROCAE for en-route and oceanic phases of flight should be considered in defining the final set of applications included in the work.

The definition of new responsibilities of each actor, and task sharing between human and system for all meaningful combinations of separation modes has to be investigated. The impact of airspace/sector design or manoeuvre limitations will be considered.

Moreover, relations between safety and capacity should be particularly studied, aiming at decreasing the number of critical incidents despite increasing traffic. Emphasize will be put on increased cost efficiency measures during the validation of new sector team organizations.

This project will provide requirements bearing on trajectory management functions to the 4D Trajectory Management project PJ18.

Performance Goals

- Increase Safety
- Increase Capacity (Airspace En-Route)
- Increase Cost Effectiveness (sector team organization and human performance)
- Increase Environmental Sustainability

3.12 PJ10b – Separation management in TMA

PJ.10b	Separation Management in TMA
Problem Statement	

The current operation within TMAs is highly tactical with the use of multiple radar vectors and stepped climbs and descents to maintain separation between aircraft in high traffic situations and it is specially challenging due to complex interactions between the multiple arrival and departure routes. This leads to less efficient flight profiles and high levels of workload for both ATC and the flight crews. Additionally, these less efficient profiles increase the amount of fuel uploaded and/or burnt and can increase the noise footprint of the operation. It makes it also very difficult to balance the operators' requirements in terms of flight efficiency (notably user-preferred trajectories) with the need for overall capacity, safety of the operations and ATC workload.

Occasionally, where no further splitting of sectors is possible due to limited controller resources, the sector demand exceeds the available controller capacity resulting in flow restrictions, level-capping and other measures that ensure safety at the expense of flight efficiency and timeliness.

Future TMA environment is anticipated to be even more loaded and complex, and substantially different from today, as full business and mission trajectories will be used.

There is a need for improved separation provision and sector management in high density TMA where transition to free route airspace and mixed mode operations based on RNAV and RNP specifications are implemented. Thus new enhanced ATC tools and the development of new concepts are required, to allow for different controller team structures to suit various airspace structures, various traffic levels and complexities.

The separation management concepts developed in SESAR1 have, in some cases, required development of an underlying trajectory prediction capability to generate the trajectories required to support conflict detection, conformance monitoring and sector team roles. These Trajectory Prediction (TP) requirements are independent of the RBT and the trajectories are built locally (i.e. are not shared) to support the specific use in the required ATC tool. TP requirements produced in SESAR 1 include:

- Building of separate trajectories to support the various planning and tactical tasks
- Building of speculative trajectories to support "What-If" functions
- Incorporation of AOC data together with EPP (Extended Project Profile) and DAPs into ground-based trajectories
- Use of trajectory information such as uncertainty.

In addition, work has been undertaken to develop TP algorithms in the TMA domain to support aircraft flying in lower-level airspace, holding functionality, and the handling of transition altitude.

High level solution description

The maturity level that has been achieved in SESAR 1 for the TMA environment is lower than for the En Route environment. Depending on the previously achieved maturity levels and depending on the operational environment different numbers of iterations of development and validations cycles will be necessary.

The objective is to propose strategies and approaches so that in future environments the ATCOs can manage separation in a safe, orderly and expeditious way. This encompasses:

- Enhancement of current assistance tools through an improvement of their performances, e.g.
    - Enhanced ground TP
    - Shared information
    - EPP

- Integration of ASM and mission trajectory data

- Addition of new functionalities, e.g.:
    - Automatic detection of conflicts
    - What If, What Else probing
    - Civil/military coordination
    - Block level conflict detection to support cruise climb
    - Profile constraints
    - Removal of boundary co-ordinations
- Validation of new separation aids by providing new ATC support tools for TMA environment, e.g.:
    - CD & CR tools
    - autonomous conflict resolution tools
    - Conformance and Intent Monitoring
- Validation of new sector team organizations and responsibilities distribution together with associated assistance tools in order to provide a more strategic environment to optimise flight profiles, minimise delays, increase ANSP cost efficiencies.
- Validation of the integration of new ATC separation management and queue management functionalities where applicable
- Quantification of the value provided by RNP specifications (as defined in the ICAO PBN Manual) to radar separation minima

It is expected that the ground-based trajectories will include the incorporation of increasing amounts of airborne data and data from other sources.

The definition of new responsibilities of each actor, and task sharing between human and system for all meaningful combinations of separation modes has to be investigated. The impact of airspace/sector design or manoeuvre limitations will be considered.

Moreover, relations between safety and capacity should be particularly studied, aiming at decreasing the number of critical incidents despite increasing traffic. Emphasize will be put on increased cost efficiency measures during the validation of new sector team organizations.

This project will provide requirements bearing on trajectory management functions to the 4D Trajectory Management project PJ18.

Performance Goals

- Increase Safety
- Increase Capacity (Airspace TMA)
- Increase Cost Effectiveness (sector team organization and human performance)
- Increase Environmental Sustainability

3.13 PJ11 – Enhanced Safety Nets for En-Route & TMA Operations

PJ.11	Enhanced safety nets for en-route & TMA operations
Problem Statement	

The first instalment of SESAR allowed to develop solutions on the following initial problems:

Initial Problem	Solution Progressed in SESAR 1
At present, STCA for TMA are being implemented with difficulties due to the specific TMA structure (e.g. arrival / departure sectors, interface with en-route sectors), as well as traffic patterns (e.g. VFR traffic in the vicinity or in the same TMA).	The use of multi-hypothesis for the future trajectory (i.e. linear extrapolation + extrapolation according to known operational patterns) in the STCA has been brought to V3 maturity.
In current and near term operations, there is room to improve the STCA, through surveillance enhancements.	The use of some Downlinked Air Parameters (Selected Flight Level and Track Angle Rate) in STCA has been brought to V3 maturity.
Pilots do not always follow their Resolution Advisory thus undermining the safety enhancement brought by ACAS.	The automatic response to ACAS Resolution Advisories through a link between ACAS and the AutoPilot has been brought to V3 maturity.
Unnecessary RAs can occur when aircraft approach their cleared flight level with a high vertical rate, using the altitude capture law coded in their flight management system (FMS).	The use of a specific altitude capture law, triggered when a TA occurs for an aircraft located in the direction of the cleared flight level, and reducing the vertical rate, has been brought to V3 maturity.
In current operations, there is room to improve the collision avoidance performance, both through logic and surveillance enhancements.	The optimisation of the TCAS II v7.1 thresholds, by reducing some of them to avoid some unnecessary Resolution Advisories while keeping the safety benefits, has been brought to V3 maturity. The use of ADS-B data for improving the TCAS II v7.1 filtering of aircraft with a high Vertical Miss Distance has not demonstrated enough benefits and was considered not worth progressing beyond V1 maturity.
Pilots do not always report quickly or even at all that there is an RA ongoing, thus opening the possibility of a conflicting instruction from the controller.	The display of downlinked Resolution Advisories on the Controller Working Position and its use by the controller should have been either proven unsatisfactory or progressed to V3 maturity.

The remaining problems at the end of SESAR 1 are the following:

Ground-based safety nets have been developed to play a role of last ATC safety layer for current operations and current separation modes. The performance requirements for these Ground-based Safety Nets are dependent on the operational environment (e.g. the separation provision in the specific airspace) and specific traffic situations to be taken into account (e.g. aircraft convergence on specific traffic patterns). There is no guarantee that existing ground safety nets will be effective and will provide alerts of actual or potential hazardous situations when SESAR trajectory-based operations and new separation modes are introduced.

Within SESAR 1, the adaptation of ground-safety nets to trajectory-based operations has been studied but stopped in V2, due to lack of some data which should be available in the timeframe of SESAR 2020. The adaptation to new separation modes has not been studied.

Currently alerts that occur in the air and on the ground in close time proximity can lead to overlapping decisions by pilots and ATCOs (e.g. reactions to close STCA alerts and ACAS resolution advisories). Indeed, existing Ground Safety Nets have been developed independently from airborne Safety Nets (in particular ground-based SNETs have been implemented in a local context while ACAS has been implemented globally) and therefore the operations resulting from their alerts are not always compatible.

Within SESAR 1, the integration of ground-based safety nets and airborne safety nets has not been studied.

ACAS performance requirements have been based on current modes of separation, but not for the future operations identified by the SESAR Concept.

Within SESAR 1, the adaptation of ACAS to trajectory-based operations should have been brought to V2 maturity and can be further progressed. The adaptation of ACAS to new separation modes has not been studied.

High level solution description

SESAR 2020 will:

- Adapt ground-based safety nets to SESAR future trajectory management and new separation modes through the use of new surveillance means and wide information sharing ensuring their continuous role of last ATC safety layer against the risk of collision (and other hazards);
- Integrate ground-based and airborne safety nets in SESAR future trajectory management and new separation modes through new requirements in ground-based safety nets;
- Adapt ACAS operations to SESAR future trajectory management and new separation modes through:
  - the optimisation of ACAS resolution advisories;
  - the use of enhanced surveillance taking advantage of ADS-B information;
- Provide inputs to global and regional standardisation, within ICAO (in coordination with FAA for ACAS), EUROCAE and RTCA.

Performance Goals

- Increase safety, reducing the number of ATM related accidents and incidents

3.14 PJ13 – Air Vehicle Systems

PJ.13	Air Vehicle Systems: RPAS, General Aviation and Rotorcraft systems

Problem Statement

The successful integration of civil Remotely Piloted Aircraft Systems (RPAS), General Aviation (GA) and Rotorcraft with the Commercial Aviation is a key issue for the SES. A failure in obtaining this aim could result in restrictions to the accessibility for those classes of vehicles, or lead to issues that adversely affect safety (such as airspace infringements).

Currently, civil RPAS operations are not integrated into the ATM environment and civil RPAS can only fly in segregated airspace. Moreover, there is a lack of regulations on the subject and the implementation, certification and flight-authorisation plans are fragmented and conducted at national level.

One of the purposes of the present project will be to ensure a cross-fertilisation of technical solutions between civil RPAS and GA/R and this will be obtained thanks to a technical coordination between the project areas.

High level solution description

The project is aimed both to develop and verify the technical solutions (including CNS) that are necessary to support the operational ATM Solutions. The operational aspects will be developed outside the scope of this project, but technical solutions and operational aspects will have to be subject to an integrated validation process.

The technical solutions that will be addressed into the present project are listed here below:

Enable integrated civil RPAS operations:

- Address civil RPAS integration in the ATM system (non-segregated airspace).
- Integrate civil RPAS safely and transparently into non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system.
- Fill the technical gaps identified for the civil RPAS integration into non-segregated airspace, in accordance to the ‘Roadmap for the integration of civil RPAS into the European Aviation System’ and in accordance to the expected “RPAS Definition Phase” study results.
  - Detect and Avoid (cooperative and non-cooperative aircraft, airspace, terrain and obstacles, weather), including interoperability with existing systems as required. (e.g. ACAS and ATC support tools such as STCA/MTCD).
  - ATC Voice and data link communications and data link Communications for Command & Control functions for all types of operations, control mode types and datalink communications architectures.
  - Satellite and/or terrestrial navigation equipment, including back-up/continuity systems for GNSS.
  - Surveillance equipment such as ADS-B,
  - Flight planning/replanning capabilities, mission management capabilities (i.e. the capability to manage some specific phases of the flight with intelligent automation, e.g. contingency in case of lost link),
  - Connectivity to AFUA for managing special airspace needs,
  - Automatic Landing/take-off technologies,
  - Taxiing and surface operations systems,
  - RPAS system security solutions
  - System Wide Information Management Integration including performance assurance and interoperability functionalities to meet the requirements of trajectory-based operations and the interoperability with ASM tools and procedures.
  - Safe automated health monitoring & fault detection,
  - Other emerging technologies, consistently with the outcomes of the RPAS Definition Phase.

<u>Integrate General Aviation and Rotorcraft (GA/R) operations in the European Air Traffic Management System:</u>

- GA/R, particularly when operating outside controlled airspace, has a different set of separation and alerting needs to enable it to optimise the use of electronic visibility in that environment. Additionally, electronic visibility might be enabled by means other than ADS-B in some areas.
- There is a clear need to address potential ADS-B IN applications of all categories (situational awareness, separation, conflict detection & resolution) for GA/R in unmanaged airspace and low density managed airspace.. This must take into account the changing environment in this airspace (e.g. introduction of RPAS) along with the SESAR related developments (e.g. ability to use trajectory information). The ADS-B IN requirements need to be analysed.
- While GNSS-based systems cost-effectively provide for sufficient accuracy and integrity, continuity is an issue for GA/R. A cost-effective suitable back-up/continuity system for GNSS needs to be developed or explore how existing technologies/systems can cope with the necessary continuity requirements.
- Cost-effective solutions enabling interoperability with CAT 3D need to be developed for low-end GA/R, taking into account performance and wind/temperature information for higher accuracy trajectory prediction.
- Increased situation awareness for GA/R needs to consider also other (non-traffic) type of threats like terrain, obstacles, etc.
- Synthetic vision guidance systems, such as AdvCVS, will enable further extension of the visual segment with needed integrity, higher situational awareness, as well as other needed features for both GA/R, with respect to obstacle tracking and warning, during flight as well as during approaches on less equipped airports..
- Cost-effective solutions for special GA/R (i.e. emergency services) need to be developed, taking into account specific performances of those missions.
- Analyse how GA/R can maintain interoperability with the wider ATM system, without necessarily equipping with the same data link solutions. Satellite communications and GSM-based terrestrial air-ground data link could be considered.
- ADS-B applications (situational awareness, separation, conflict detection and resolution) for rotorcraft
- A better definition of the ADS-B IN broadcast services for GA/R (METAR, TAF, NOTAM, PIREP, SUA etc.)
- Use of data link on civil rotorcraft (e.g. CPDLC, 4D).
- Cost effective solutions to enable trajectory negotiation, in particular in adverse meteorological conditions need to be developed taking into consideration the specificities of Rotorcraft and possibly GA. It could involve specifics FM developments, use of appropriate Data link solutions and Integrated Weather Information Management System.

Performance Goals

- improve accessibility to airspace and airports for GA and Rotorcraft users, whilst maintaining or increasing the safety level of operations
- capacity: (metrics to be defined as regard to RPAS airspace capacity)
- allow accessibility to airspace for RPAS, whilst maintaining or increasing the safety level of operations.

3.15 PJ14 – Communication – Navigation - Surveillance

PJ.14	Communication – Navigation – Surveillance (CNS)
Problem Statement	
CNS technologies on the ground and onboard the aircraft are an essential underlying technical enabler for many of the operational improvements and new procedures being developed within SESAR. Performance requirements for CNS systems are becoming increasingly complex and demanding and need to considered as part of an integrated air and ground CNS system considering convergence towards a common infrastructure, where possible, across the different domains. In parallel, CNS systems and infrastructure for both airborne and ground must take a more business-oriented approach with efficient use of resources delivering the required capability in a cost-effective and spectrum efficient manner. Dedicated studies on CNS technologies and infrastructure have already been performed within the frame of SESAR 1. This has resulted in a roadmap for CNS technology and infrastructure which will support the evolving SESAR concept of operations. Strong links need to be established with operational requirements and other relevant areas within other SESAR projects (including e.g. SWIM, air vehicle systems).The project activities will aim a) to ensure that new potential CNS solutions fully meet the requirements derived from operational needs, and b) that the SESAR projects take into account the limitations of these new emerging CNS technologies but will also fully exploit their new capabilities. Civil-military CNS interoperability aspects must be covered in this project. This must comprise CNS capabilities to support required military operations including enabling Mission Trajectory.	
High level solution description	
In each of the three (Communication, Navigation and Surveillance) domains, viewed both independently and, given increasing reliance on common infrastructure, as an integrated CNS system, functional and performance improvements have to be developed and validated, through a series of activities including (for both ground and airborne): • Collection and analysis of requirements (operational, safety, security, performance) from all relevant SESAR1 and SESAR2020 projects and relevant external activities (e.g. standardization groups) and feedback on achievability of the requirements. • CNS solution design and specification. • Pre-development, modelling and prototypes. • Technical development, integration, verification and validation (where appropriate installation/deployment of related infrastructure and technology for conducting validation exercises). • Interoperability testing <u>Integrated CNS evolution will include (guided by operational outlook/requirements but not limited to) </u>for both ground and airborne<u>:</u> • Identify potential technological/functional synergies across the COM, NAV and SUR domains to benefit from common system/infrastructure capabilities. • Integrated CNS spectrum planning including civil-military coordination and aviation frequency bands CNS technology sharing. • COM, NAV and SUR robustness studies and guidelines regarding interference and security including those caused by non-ATM systems and technology. • Assessment of the robustness mitigation and common failure modes in an integrated CNS System, particularly regarding common infrastructure use and an integrated modular avionics approach. • Civil-military CNS interoperability aspects including identification of interoperability targets to support performance based compliance. • Integrated CNS architecture as an input to SESAR2020 ATM Design & Integration project (Pj19) Specific CNS evolution will include (but are not limited to) for both ground and airborne<u>:</u>	

Communication :

- Data link technology (physical layer) evolutions for A/G comprising future terrestrial and SatCOM solutions).
- VDL/2 multifrequency performance and interoperability testing in busy RF environment.
- ATN/IPS (IPv6) based Air-Ground data link with consideration for backward ATN/OSI compatibility.
- Evolution of G/G to IPv6 communication.
- Communications infrastructure multilink concept (ground infrastructure and avionics architecture including software defined radio).
- Civil-Military requirements and Interfacing/interoperability between civil-military networks
- Communication system performance monitoring and supervision.

Navigation :

- Dual/Multi-frequency/multi-constellation GNSS, including avionics aspects, to support PBN, i4D and SUR applications/requirements.
- GBAS (elicitation of requirements and demonstrating feasibility to support future approach, surface and take-off operations, including CAT III operations) for L1 and in a dual frequency multi constellation GNSS environment.
- Military GBAS (JPALS) equivalence and interoperability.
- SBAS supporting RNP operations, including CAT II/Cat III and autoland
- Alternative means Position Navigation Timing (A-PNT) (new terrestrial technologies e.g. Mode N, aircraft based systems and DME evolution; higher integrity navigation systems and fall-back navigation systems in absence/loss of GNSS).
- Navigation system performance monitoring and supervision (considering the ground, aircraft and space segments).

Surveillance :

- Cooperative surveillance infrastructure (Mode S, WAM, ADS-B) and performance-based surveillance (including a definition of performance criteria and measurement tools; e.g. online sensor quality control, online tracking quality control).
- Enhanced surveillance multi-sensor tracking and data distribution,
  - to support seamless air/ground tracking (-> enabler for other projects, e.g. airport-related) and
  - to incorporate new sensor technologies such as video camera/laser scanner, non-cooperative surveillance like MSPSR et. al.,
  - to integrate new infrastructures such as space-based ADS-B or new positional sources like docking systems,
  - to enhance feature data fusion such as with aircraft downlink data.
- Future non-cooperative surveillance technology – e.g. but not limited to MSPSR (including mitigation of the adverse wind farm effects).
- Enhanced airport surveillance e.g. integrating video surveillance in support of remote tower developments and ASMGCS.
- Satellite-based ADS-B.
- Evolution of ADS-B data link for enhanced security and new/advanced functionalities (including avionics needs).
- Surveillance system performance monitoring and supervision.

Performance Goals

Performance goals need to be in line with the Operational Improvement Steps, with there being a close interdependency regarding the overall deployment package. CNS enablers (future CNS technology/ infrastructure) must contribute as a necessary prerequisite towards implementing Operational Improvement Steps.

In addition to future CNS technology/ infrastructure, there is a need to ensure an optimized CNS ground infrastructure (coherent with the available avionics capabilities) in order to reduce the cost of service provision (e.g. rationalization of infrastructure). This prerequisite applies to future and legacy infrastructure as well as to a decommissioning of obsolete legacy infrastructure (development of a decommissioning roadmap).

3.16 PJ15 – Common Services

PJ.15	Common Services

Problem Statement

A generic principle of the SES and the SESAR programme is that where services can be delivered in a harmonised manner, they should be. A Common Service is a service to consumers that provides a capability in the same form that they would otherwise provide themselves. Examples of where Common Services would be applicable are Air Navigation Services or their related functions that are exercised at European, network, FAB, local or other level and that provide benefits in one or more performance areas such as cost-effectiveness, safety, capacity, environment and predictability. The European ATM Master Plan and SESAR 2020 need to show in the definition of the future high level ATM system architecture the different options for the provision of harmonised services.

SESAR 1 focussed on:

- Agreeing a common definition of a Common Service using existing policies focussing on the objective and benefits of improved efficiencies in European ATM. This included the development of the pre-selection criteria applied against candidate services taking into consideration the priorities of stakeholders such as air space users, airports, ANSPs and Industry and the SJU and interests of the regulatory authorities and staff associations.
- The initial identification of the candidate services was based upon the examination of the Step 1 and 2 target operating concepts and their corresponding technical architecture. The work recognised that not all the users of Common Services would be civilian, so appropriate authorities were consulted when considering the impact on the military.
- The development of a structured method for the further definition of the pre-selected Common Services that included the choice of an appropriate business model and the selection of the most appropriate technical architecture to support service delivery. This method made use of a modified European ATM Architecture (EATMA) to define the service's full scope using the architecture's operational, service and technical layers and considered the stakeholder's existing investments in both their ATM systems and those resulting from the regulatory framework.
- The application of the method to the pre-selected Common Services to develop individual business models that reflected their most efficient and effective operating concept to deliver the desired benefit. The business models were then used to identify each of the service's most appropriate technical architecture after considering the required systems and use of SWIM along with the roles and responsibilities of the staff needed to operate the service.
- The preparation of an action plan for the future validation and development of the identified common service.

The scope of work undertaken in SESAR 1 was limited in both the number of candidate services examined and to the development of primarily a logical view of the architecture. Unfortunately there was limited opportunity to examine the more detailed requirements on the physical assets, both staff and systems affected by the choice of the Common Service and a more detailed cost benefit analysis. These aspects will be examined in SESAR 2020.

High level solution description

SESAR 2020 will focus on the further definition of the Common Services identified and initially defined in SESAR 1 and the identification and definition of additional services. This will include services identified in SESAR 1 but not pre-selected for further definition. The aim will be to reach for each service considered a level of maturity in definition such that its development could proceed to the industrialisation phase and that any necessary areas of rulemaking can be started to enable its later deployment. Such services will be recorded in the integrated Road Map as "Business" Improvement Steps (BIs) and considered for inclusion in appropriate Deployment Packages within the ATM Master Plan.

Of particular relevance will be to ensure that as further solutions are developed in the SESAR 2020 projects, these or their related functions are also considered as candidate Common Services. This will require continuous co-ordination with the operational and Enabling aviation infrastructure projects in the rest of the programme and most importantly, the transversal project managing ATM Design & Integration. To support this, the project will add content to EATMA to reflect the possible high level architecture options supporting the provision of the Common Services.

The project will undertake the practical verification of the Common Services to verify the proposed high level architecture and requirements. This will be co-ordinated with other projects to include the work in their exercises. It may require the development and integration of mock-ups/prototypes for the service provider and consumer systems as well as those required for communication, such as SWIM and air ground communication. The results will be used to refine the business case for each Common Service thus clearly demonstrating, where achievable, the added value of using the chosen business model for delivery. The definitions of the services will then be expanded to reflect the lessons learnt and to include safety and security assessments. The outcome of this project may be used to update the SPRs/INTEROP of the relevant ATM solution projects.

Performance Goals

- Cost-effectiveness
- Safety Improvements
- Environmental improvements (fuel/energy efficiency, noise and emissions reduction)
- Capacity improvements
- Predictability improvements

3.17 PJ16 – Controller Working Position/HMI

PJ.16	CWP/HMI
Problem Statement	
Future environments of Airport ATS, TMA and En-Route are anticipated to be more loaded and complex. Improved Air Traffic Service will require substantially different management (notably using full business/mission trajectories) to work at the optimum efficiency, capacity and safety. Required improvement of Operations connected to an increased number of information sources will require automation and new tools to assist Airport ATS, TMA and En-Route Controllers, providing with all relevant information, at the right time, in an easy and intuitive way. Information management and systems & services integration shall play a strategic role under the operational, technical and human factors point of view. Notably a possible separation of some ATM Information Providers from ATM Business Services providers to go towards Virtual Centre approach would require a clear open and common service-oriented interface based on open architectures and technologies, in particular between the controller workstation (as ATM Service) and the related Information providers. The development of technical services and common interfaces resulting from new technologies, working methods, Service Oriented Architectures (SOA) and procedures would also need to address human factors considerations. The proliferation of proprietary systems with proprietary interfaces and not user friendly HMIs shall be avoided.	
High level solution description	
The project deals with Operational and Technical objectives but does not address the “look&feel” aspects of the HMI as this is managed by the relevant SESAR solution projects. The project has two main streams of activities: 1. Defining the architecture of the future CWP/HMI in order provide the technical means to ensure the separation between ATM Business service provision and ATM information Providers, e.g. Virtual Centre. It includes the development of prototypes to verify the CWP / ATM Architecture interface. 2. Developing the CWP/HMI prototypes that will be used by the SESAR solution project in accordance with their requirements. High level objectives are summarized as : <u>Operational objectives</u> • Analyse future airport ATS, TMA and En-Route working environment including organisation, staff roles, tasks, equipment and tools. • Collect operational requirements that impact on the CWP/HMI from SESAR solution projects and ensure their consistency/coherency by defining a common and consistent set of technical requirements including contingency measures / human factors / safety / resilience and HMI requirements for future CWP. • Perform additional human performance assessment having in consideration ergonomic and new technology screening studies and safety & social aspect. • Build upon the outcome of SESAR1 operational projects addressing CWP. <u>Technical objectives</u> • Define and develop the CWP architecture including its functional specifications complying with the operational requirements (including human/safety requirements) for future CWP. • Define Business Services (and the corresponding technical services and interfaces) to enable the possibility of decoupling the CWPs owned by the ANSPs from the information services provided by ATM Information Providers (ADSPs), as a basis for an industry standardisation. The technical services and interfaces should take care of Configuration, Supervision, Recording and Adaptation models, Performance aspects (including network performance and load), Security & Safety Aspects. Considerations about possible standardization and related technologies are expected to be produced. • Collect and generate Interaction Design Patterns for functions in the HMI out of different projects.	

Test and measure these Interaction Design Patterns according to common standards and provide them in a database to be used by the projects.

- Develop and verify prototypes supporting the technical validation of the proposed CWP / Service Interfaces and of the decoupling between the CWP and remotely provided information and data services (e.g. Virtual Centre)
- Develop and verify the CWP prototypes required for operational validation exercises in the context of SESAR solutions projects.
- Develop possible HMI solutions and prototypes based on innovative technologies evaluated previously by other SESAR projects and taking into account the results and the recommendations of the evaluations performed. Not every prototype will verify the complete set of specifications.
- Build upon the outcome of SESAR1 technical projects, addressing CWP.

Verification/ support to validation objectives

- Perform technical validations of the proposed CWP / Service Interfaces and of the decoupling between the CWP and remotely provided information and data services. Usage of new interfaces in other projects' Validation Exercises will be analysed on a per-exercise basis. Many-to-many CWP to ATM system verification exercises shall be performed.
- Support validations of the defined operational concepts on CWP perspective. Ensure that the improvement of the most important KPIs (Key Performance Indicators) is considered.

Performance Goals

The objectives of developing CWP/HMI functional specifications, ergonomic and human factors recommendations and guidelines include and support:

- Increased safety
- Increased ATCO efficiency
- Increased capacity
- Improved resilience
- Application of innovative technologies
- Improved HMI and usability and performance of interactions
- Improved interoperability in Airports, TMA and En-Route domains

The objectives of Define Business Services (and the corresponding technical services and interfaces) to decouple the CWPs from the ATM Information Providers (ADSPs) include and support:

- Design, development and deployment cost reduction
- ATM cost efficiency improvement
- ANSP agility
- European ATM system integration

3.18 PJ17 – SWIM Infrastructures

PJ17	SWIM Infrastructures
Problem Statement	

In continuity with SESAR 1, there is a need for SWIM Technical Infrastructure Solutions (Air-Ground and Ground-Ground) for supporting Information Exchange Services and SWIM-enabled Applications, as illustrated in Figure 1.

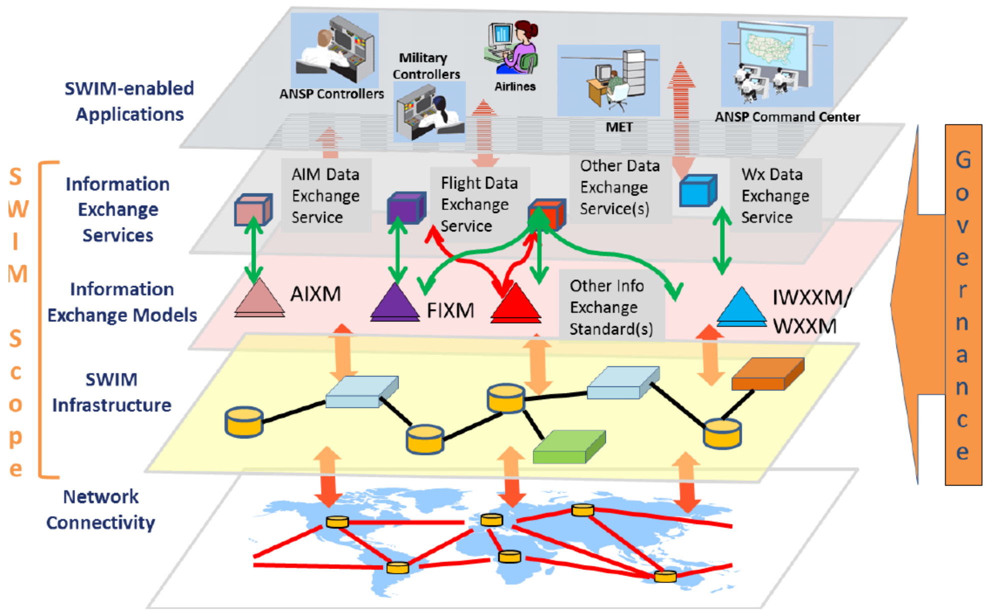


Figure 1: SWIM Infrastructure in the SWIM Interoperability Framework

As new services and information exchange will continue to be defined and refined in the timeframe of SESAR2020, it is needed to ensure proper support to those exchanges by SWIM Technical Infrastructure and to enhance and align technical documentation of already existing SWIM profiles and to support identification and description of possible new SWIM profiles.

Moreover, in SESAR2020 it will be necessary to prototype the ground instantiation of the SWIM "Purple" profile and integrate it with the airborne V2 system. The SWIM Purple profile addresses the SWIM A/G service and data exchanges necessary to support ATM operational improvements that enable better situational awareness and collaborative decision making. In addition, the current airborne system, which addresses initial A/G SWIM advisory services at the end of SESAR 1, will be enhanced to address operational, safety and performance requirements necessary to support more safety-critical services.

Another important topic will be Cyber Security, which is a highly sensitive subject in SESAR 2020. The SWIM Technical Infrastructure will also have to provide, support and enforce Cyber Security characteristics. It is therefore already foreseen that the SWIM Technical Infrastructure Cyber Security functionalities (some already specified in current SESAR) will need to be fully prototyped and validated while being open to new needs arising from other work packages.

Technology related to a range of advanced, challenging and/or innovative forms of information sharing has not or only partially been addressed in the current SESAR. To some extent this is due to insufficient maturity of the technology and/or standards. As an example, topics range from scalability such as large numbers of events and transmission of large messages to distributed databases.

High level solution description
Based on the assumption that V3 level will be achieved for the blue and yellow profiles in SESAR 1 as required by the PCP, the scope of the activities in this project will be limited to bringing the purple profile (A/G) to V3 and if necessary developing new profiles (G/G). The objective of the "SWIM Technical Infrastructure" project is to : • Define the technical means to support Information Exchange Services and SWIM-enabled Applications: – Gather information distribution and service provision needs from other projects – Interpret such needs into system requirements – Elaborate logical architecture of the SWIM Technical Infrastructure and options for the technical architecture – Evaluate and experiment standard technologies before their inclusion in the actual prototypes in order to identify the ones which best fit the operational needs and/or SWIM Technical Infrastructure Specification (which in turn must fulfil identified system requirements) • Develop prototypes of necessary SWIM Technical Infrastructure to support validations with one or more different technical architectures, considering also civil-military SWIM interoperability (ATM and Air Defence) • Global coordination ensuring interoperability between global SWIM Technical Infrastructures • Contributions to standardisation • Demonstration and Communication activities For the elaboration of the purple profile and any new profiles, the project will work closely together with ATM Design & Integration project (PJ19).
Performance Goals
SWIM Technical Infrastructure performance shall be aligned with the needs of operational activities.

3.19 PJ18 – 4D Trajectory Management

PJ.18	4D Trajectory Management
Problem Statement	
Coherent 4D trajectory management along the full lifecycle of every flight is needed to improve air traffic operations so that flights can be managed as closely as possible to the Airspace User's ideal profiles, while optimising the global flow of air traffic, managing ATM Constraints and changes due to traffic or weather hazards. Work done in step 1 focused predominantly on independent operational processes working with trajectory information on different time horizons: • Arrival Management in an extended AMAN horizon working with the ATC trajectory of the last centre, and using Controlled Time of Arrival (initial 4D operations), supported by downlinked data. • Flow Management before take-off, leading to regulated flights remaining subject to slot allocation even though the TTO/TTA information is also distributed in order to share the final objective of the regulation. • STAM processes within the medium term horizon were developed to enable trajectory negotiation among FMP's and airline users, but the trajectories being negotiated are not shared with ATC systems, and changes are only applied to the NOP. • Some processes in the ACC controlling the flight have looked at making use of the on-board trajectory prediction. Some trials validated the sharing of downlinked data but remain incomplete There is a need to improve integration between different operational processes using and modifying trajectories, for instance, negotiation of trajectories by Local Traffic Manager to solve flow control issues are facilitated through NM processes implemented for step 1, but these do not translate in updated trajectories when they concern flight already in execution. In general the RBT revision process is not fully validated at the end of step 1. The initial use of Airborne data (such as EPP) to support some ground tools forms part of the PCP, and will be validated during Step 1. it is expected that uses of airborne data within ground tools will continue to be developed beyond Step 1, requiring validation during SESAR 2020 The integration of military users' processes in the network and civil military coordination is still based on ad hoc mechanisms at the end of step 1. Strategic constraints are managed differently by FOC, NM and ATC's. Information is shared through various documents exchanges (RAD's, information on LOA's), but each system manages them differently. SESAR step 2 will bring the full Trajectory Based Operations, defined in the step 2 CONOPS and associated DOD's. The ambition of step 2 is to manage a gate-to-gate trajectory, thus the ground trajectory need to be integrated with the air trajectory, which is not yet achieved at the end of step 1.	
High level solution description	
This project will have to work closely with ATM Design & Integration project (PJ19) in charge of elaborating coherent design solutions for managing flight information across the System of Systems architecture, driven by operational requirements elaborated in the various SESAR solution projects. In coordination with PJ19 to ensure architecture consistency, PJ18 will provide the trajectory management services fulfilling the requirements expressed by projects using trajectory: PJ01-Enhanced arrivals and departures, PJ10a & b-Separation management En-Route & TMA, PJ11-Enhanced Air and Ground Safety Nets, PJ 06-Trajectory & Performance Based Free Routing, PJ07-Optimized Airspace Users Operations, and PJ09-Advanced DCB More specifically, in terms of flight information management this project will cover designing solutions that will support : • The systematic sharing of aircraft trajectories between all partners (Airport, FOC, NM, ATC and pilot) who will share a common view of a flight and have access to the most up-to-date data available to perform their tasks. • trajectory revisions (including changes to flow measures) during execution are made considering	

the complete trajectory still to be flown, and not only the one at sector level, and take into account the wider impact on other flights trajectories, the Network operations , ATC constraints and weather hazards.

- involving pilot or FOC's depending on the operational context, as well as various ATM actors.
- merging STAM and other trajectory revision processes under one uniform process that may involve different sets of users depending on the time horizons and the types of measures.
- providing trajectory modification services enabling the implementation of flow measures during execution
- improving the quality and the usability of the aeronautical information (AIM) and meteorological information by developing operational procedures and associated system capabilities (e.g. MET data and forecast analysis, AIRAC cycle shortening)
- degraded modes of operations taking into account the role of NM. (extend the benefits of G/G Interoperability to manage G/G Interoperability gaps and support degraded modes of operations taking into account the role of NM as an G/G Interoperability stakeholder)
- increasing interoperability with other ATM stakeholders (e.g. Airspace Users, Airports) in order to enable the trajectory management processes that will be defined in SESAR2020.
- the use of airborne trajectory prediction data in various ATM processes
- extending seamlessly to non-ECAC actors and neighbouring ATM partners through the compatibility with global standards (FIXM/FF-ICE)

Note: the work on this area is coordinated with the operational and system activities of the various ATM solution projects

Enriched SBT/SMT information such as user preferred user trajectories or performance impact of DCB measures on affected traffic shall be shared and updated dynamically to monitor in real-time planning processes performances. Business trajectory management shall evolve to enable the introduction of advanced airspace structures (and associated management processes). The objective is the sharing of the trajectories between the Airspace Users and the other ATM actors through an iterative process to take into account more accurate data once available (intentions, MET forecast, current traffic, airspace management, etc.) and for the Airspace User to choose the preferred way of integrating ATM constraints when required.

PJ18 will work as a transversal technical prototyping project that will :

- Definition of processes involved in trajectory management with relevant Use Cases
- Modelling of data and services linked to the trajectory, in relation with PJ19
- Definition of the requirements for the architecture supporting trajectory management processes in coordination with PJ19
- Develop prototypes for specific trials, involving ATC's, NM, FOC's, airports, based on the design work of project PJ19 and taking into consideration as well the work on purple profile (SWIM A/G) in PJ17
- Organization of trials for advanced flight information management services, in particular gap filling mechanisms, and large scale trials. Some trials might be conducted through operational projects where the G/G Interoperability benefits can be felt in operational processes.
- These trials will help preparing the VLD trials foreseen in the second wave of VLDs.
- Consolidation of requirements for trajectory calculation, coming from PJ18 and other operational projects.
- Consolidation of operational requirements towards future FIXM requirements
- Coordination of FIXM technical impact for revision beyond FIXM V4.0 (coordination with PJ19)
- Support to development of future FF-ICE document

Performance Goals

- Flexibility: match demand with minimum distortions to the Airspace User needs (Business/Mission Trajectories).
- Flight efficiency (flight is managed closer to its optimal profile)
- Interoperability (air and all ground actors share the same trajectory view)
- Trajectory accuracy (airborne data allow improve ground trajectory used by Ground Automated Tools)- relates to predictability

In addition, it will have indirect impact as an enabler to other operational projects.

3.20 PJ19 – ATM Design & Integration

PJ19	Title: ATM Design & Integration
Problem Statement	

The SESAR research, development and validation activities shall serve one common concept, which elaborates changes of European ATM architecture in order to contribute to the common European performance targets.

A successful approach to achieve this necessitates that

- solutions developed by the programme are coherent and consistent
- solutions developed by the programme fit into the architecture framework and contribute to the overall performance targets and the associated concept
- solutions developed by the programme are transparent and visible and their dependencies are clearly identified and managed
- solutions developed by the programme support programme management decisions and ATM Stakeholder decisions for investment and deployment
- solutions developed by the programme fit into the global ATM developments
- solutions are commonly developed to ensure their acceptance by all stakeholders.

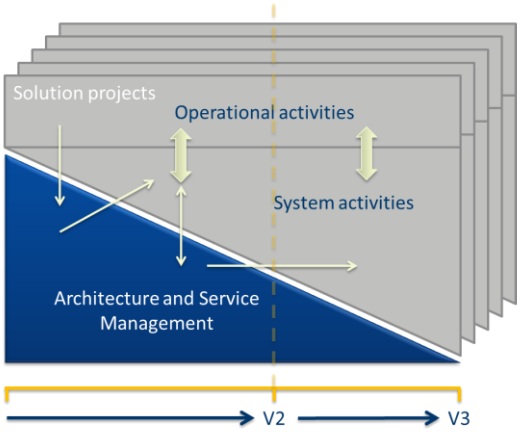
To ensure this holistic approach

- the coherent architecture and design of “SESAR solutions” in the V1 and V2 lifecycle phases need to be brought together into a holistic framework
- guidance and steering needs to be given to development and validation activities in order to ensure consistency and coherency
- the output of this project shall support management decisions of the programme
- a single reference architecture for ATM has to be developed and maintained, including the transition steps to evolve from the baseline towards the target.

High level solution description

The SESAR 2020 Programme requires decisions to be taken on major changes in operations and architecture to achieve the objectives of the Master Plan. While the decisions will be taken by the governance structures that will be put in place in the programme, there is a need for a project to prepare material in support of content steering and guidance, which addresses the above requirements for a successful approach to the change of ATM in Europe.

The envisaged changes of business, operations and technology need to be brought together (collected and consolidated), dependencies need to be identified and consistency and coherency have to be assured. The creation of a transparent and holistic picture of change serves the projects of the programme, the stakeholders and the management of the programme to support decisions for R&D, deployment and investment.



The various R&D projects of SESAR 2020 develop and validate SESAR solutions. The role of this project is to facilitate, coordinate and consolidate these operational and technical solutions, to ensure their consistency and coherency from a holistic perspective of the overall concept and architecture.

The interaction between this project and the SESAR solution projects is different depending on the lifecycle maturity phase[3].

In the first wave of SESAR2020 the role of this project in relation to projects dealing with topics planned to reach V3, will be rather limited to capturing refinements and feedback that follow from the verification and validation activities, and to using the overall architecture perspective to coordinate changes where necessary between different SESAR solution projects. At the same time the project will focus with priority on the solution and services architecture for the SESAR solutions that have not reached V2 yet. The project will prepare analyses of the 'major' architecture design decisions to be taken, and will prepare relevant material for the decisions to be taken by the programme governance body (-ies).

It is foreseen that the system activities of the various SESAR solution projects may support the architecture analysis activity by performing early mock-up and prototyping activities. At this stage there is still a sufficient flexibility in terms of mapping logical architecture elements onto possible operational and technical realisations.

A final output of this project for the first wave will be the (refined) scope of specific SESAR solutions (basically OI steps and Enablers) to be elaborated in detail and validated to V3 level by the SESAR solution projects during the second wave.

During the second wave, this project will again capture refinements and feedback that follow from the ongoing V3 verification and validation activities and at the same time it will focus on 'designing' the SESAR solutions for beyond SESAR2020.

All activities within the project are related to each other and are elements of the overall architecture. The architecture should be stored in a single repository in order to ensure the transparency, consistency & coherency of the Work Programme and to serve as a support tool for decision making.

As a truly transversal project it must be deeply embedded in the programme and establish a close working relationship with nearly all projects of SESAR 2020.

The project is in charge of addressing the following areas:

Architecture framework:
- Adapting and updating the architecture framework to fit the need of SESAR2020 (e.g. modifying the architecture rules, meta-model, processes, practices, cyber security approach) in relation with the deployment activities.
- Prepare the architecture material needed to support the decision making processes and groups
- Based upon decision making groups directives, support the SJU to ensure that the SESAR2020 development and validation activities are consistent, coherent and conform to those directives.
- Liaise with other Global efforts aiming at establishing the ICAO Global Interoperability Framework

Business:
- Defining the European ATM business model and needs that will drive the evolution of European ATM.

Integrated Roadmap of capability increments (IR):
- Manage, baseline and promulgate the Integrated Roadmap (IR):
- Maintain the reference of the operational and technical changes developed in the SESAR Programme (e.g. Operational Improvement Steps, Enablers)
- Note: the work on this area is coordinated with the Master Plan Maintenance project

Operations:
- Describe the concept of ATM operations in Europe for all stakeholders (ConOps) in order to meet the future performance needs of European ATM. Assure a common and consistent understanding of the operational characteristics of ATM, and the main significant changes in operating practices along with the capabilities required. The ConOps shall make provisions for global interoperability.
- Maintain and update the high-level operational requirements as well as its refinement down to a level

[3] This description is based on the latest understanding and lessons learned from SESAR1 and will be subject to evolution following experience gained in SESAR2020.

that allows defining the OSED, INTEROP and SPR per project (DOD like).

- Maintain and update a high level Validation Strategy (VALS) for the different operational domains (same scope as DOD) defining the validation approach apportioned per SESAR solution (performance, need for integrated validation, …).
- Develop and maintain the operational architecture model supporting ATM operational concepts.
- Note: the work on this area is coordinated with the operational activities of the various SESAR solution projects
- Research and develop a “business rules concept” for the ATM information domain, in order to ensure that the data provided to each particular stakeholder is fit for the intended use.

Information:

- Describe the information architecture to ensure the efficient and consistent use of ATM information and global interoperability
- Update and maintain the inventory of SESAR terms (SESAR Lexicon), with the corresponding definition, to harmonize their use in the Work Programme.
- Maintain and evolve the information views (ATM Information Reference Model - AIRM) representing the data shared between the stakeholders, which shall be updated periodically during the programme lifecycle.
- The AIRM shall represent all the ATM information constructs that are used in the ATM world and are part of the SESAR Concept.
- The SESAR 1 AIRM structure and content shall form the basis for further developments. The AIRM will contain definitions of entities that are part of an ATM operational language.
- To contribute to AIXM and WXXM international data exchange standards, and where appropriate to international standardisation;
- Ensure coordination and consistency with the Trajectory Management PJ18 in relation with FIXM international data exchange standards, and where appropriate to international standardisation;
- Note: the work on this area is coordinated with the operational activities of the various SESAR solution projects

Services:

- Develop and Maintain the Service Architecture defining services applied within the European ATM
- Coordinate and maintain the service roadmap in order to facilitate, coordinate and prioritize the development of services
- Update, maintain and publish the service views.
- Research and define how ATM data can be better managed (from operational, technical and organizational perspective) and providing value to consumers and develop associated material.
- Research and define the means by which the ‘authoritative data source’ concept can be managed at entity and attribute level, in order to enable the provision of the right data for each intended use.
- Research and define the means by which the ‘seamless’ (overall temporal and spatial) integration of different ATM domain data can be achieved to enable consumers with a complete common operational picture. Hereto the 4D Weather cube concept will be studied and from it possible application ideas for other domains will be derived. This means that the cubes concept is analysed and its wider applicability in the context of PJ19 work is explored.
- Coordinate with Trajectory Management PJ18 to integrate and align the trajectory management related services satisfying the SESAR solution project related needs.

Systems:

- Ensure that the description of the technical system architecture follows the open system architecture approach.
- Inter-system technical architecture: Describe the ATM inter-system technical architecture (ADD).
- Intra-system technical architecture: Describe for each domain system its intra system technical architecture (TAD/domain).
- Verification of the systems architecture against the logical architecture using some model-based simulations techniques
- Assurance that Very Large scale Demonstration technical systems are set up in accordance with SESAR Technical System Architecture
- Develop and maintain the technical architecture model supporting ATM systems aspects.
- Note: the work on this area is coordinated with the system activities of the various SESAR **S**olution projects

Standards :

- Identify the standardization activities needed to support the deployment of SESAR improvements.
- Note: the work on this area is coordinated with the operational and system activities of the various SESAR Solution projects

European ATM Architecture repository management:

- Manage the release planning for the content of the EATMA repository
- Organise the change management of the various areas of the EATMA repository
- Manage and control the population process of the EATMA repository (MEGA tool), which contains architectural elements like strategies, business requirements, performance, capabilities, operations, services, systems, information and standards and the relationship between these elements. The information on all these elements comes from the activities in the areas described above.
- Maintain the supporting tool-environment (repository + portal) needed to depict the European ATM-Architecture and provide access via web portal to the SESAR stakeholders
- To define and establish a network of interoperable registries/repositories (including run-time as well as organisational aspects) aiming at making relevant ATM information services globally interoperable;
- Remark: All roadmaps developed by experts within the frame of this project will be part of the European ATM Master Plan.

3.21 PJ20 – Master Plan Maintenance

PJ.20	Master Plan Maintenance
Problem Statement	
Maintain the ATM-Master Plan (ATM-MP), update and publish ATM-MP editions. Manage the Master Plan update campaigns.	
High level solution description	
It is expected to conduct 1 ATM Master Plan update campaign before 2020. The update of the Master Plan will incorporate the results of the RPAS definition phase. It will identify the specific R&D activities to be conducted as well as any RPAs dimension to be introduced in other R&D activities. The project is in charge of executing the following processes and activities: Master Plan: The ATM-MP includes three levels: The Executive View (Level 1), the Planning View (Level 2: Performance Needs, Integrated Roadmap + Deployment Packages/Deployment Scenarios (DP/DS), standardisation and regulatory roadmap) and the Implementation View (Level 3: ESSIP Objectives). Activities and processes are: • Manage the Master Plan campaign to publish the ATM-MP edition 4 (three levels). • Outline the essential and other operational and technological changes that will provide SESAR contributions (besides other initiatives) to achieve the European SES high-level goals. • Manage the ATM-MP portal that in addition to providing the 3 levels of the ATM-MP also integrates and provides access to the architecture (EATMA), the Integrated Roadmap, the lexicon and the standardisation and regulatory roadmaps. Deployment Package /Scenarios (DP/DS) + Incentives: • Identify which changes need to be grouped/synchronised (including where and when) to optimise the benefit of their deployment making use of consolidated performance assessments and Cost Benefit information. • Detail the changes (at OI Step and Enabler level), the stakeholders who are in charge of the deployment, the deployment timeframe and the operating environments where the changes will impact and deliver benefits as well as considering the incentives and the regulation and standards needed to secure their deployment. Using performance assessment information, determine the effectiveness of Deployment Packages. Identify and assess change management aspects for each Deployment Package. This is the input for the prioritisation at Level 1 resulting in the Essential Operational Changes. • Develop proposals for operational and financial incentives (using also early Regulatory Impact Assessment (eRIA) findings) for mitigating deployment risks. These incentives can be generic or specific depending on the nature of the improvement deployment to be de-risked. Performance Planning (Needs): Performance planning addresses performance needs for the medium to long term time horizon. It describes needs to operational environments and geographical areas per intermediate years. Performance needs fit within the SESAR Performance Framework as defined by P21 Performance Management and are reviewed at the time of updating the ATM-MP. Close coordination with PJ21 will be required to ensure appropriate relationships between Performance Needs (in PJ20) and Validation Targets (in PJ21) (performance framework in PJ21 and performance needs values in PJ20) Implementation Planning and Monitoring (ATM MP L3): Implementation Planning translates Master Plan Level 2 into a deployment view; it relies upon a transparent reporting and monitoring process. The main scope of the Master Plan Maintenance project is to administrate the up-to-date maintenance of the European ATM Master Plan. This includes ensuring the ATM performance needs and expectations are correctly established at the highest level and can flow into the programme to drive R&I prioritisation. This means there must be a close collaboration, in particular, with the Performance Management project.	

With particular regard to the Master Plan Maintenance, the arrival on the deployment scene of the Deployment Manager will bring the SJU to reconsider the current set up for the maintenance activities, with particular regard to the level 3 of the Master Plan. While the overall responsibility of the Master Plan is assigned to the SJU there will be a need for a very strong coordination with the Deployment Manager from this perpective.

Support for definition of Common Projects:

- Provide expert level input that will be the building blocks supporting the definition of future Common Projects, providing a mandate is given to the SJU to support the EC for these type of tasks.

Regulation:

- List the regulatory activities needed to support the deployment of SESAR improvements.
- Maintain the regulatory roadmap for the part related to SESAR.

Standardisation:

- Consolidate Standardisation Needs making use of standardisation cases. The standardisation cases will be developed using expertise provided by the SESAR 2020 projects. These standardisation cases will be used to support decision-making processes, which are out of scope of this project.
- Maintain Standardisation Roadmap for the part related to SESAR.

3.22 PJ21 – Performance Management

PJ.21	Title: Performance Management
Problem Statement	
Maintain, support and ensure the application of the performance framework to be applied by the SESAR2020 projects. Ensure the harmonised performance assessment for all SESAR Performance Areas. Provide specific reference and guidance for Safety, Security, Human Performance, Environment and CBAs conducted by the SESAR Solution projects. Provide as well coherent performance management support to Very Large scale Demonstrations (VLD) and Exploratory Research ATM-oriented Research projects.	
High level solution description	

The SESAR Performance Areas for Performance Management are: Safety, Security, Environment, Human Performance, CBA, and Overall Performance – e.g. Predictability, Punctuality, Capacity, Cost efficiency, Civil-Military Coordination (incl. Mission effectiveness).
The responsibility for the SESAR 2020 Project level performance assessment remains with the corresponding projects, including effort allocation. In Performance Management, performance assessments will be conducted only on a higher aggregation level. Performance Management provides a coherent performance management support to Industrial Research, VLD and Exploratory Research.
The project is in charge of executing the following processes and activities:
• Define and maintain the performance framework and set the performance expected from SESAR R&D to contribute to achieving the SES high level goals set in the ATM Master Plan and satisfy the Performance Needs.
  o Define and maintain the Performance Framework to set and assess performance at an aggregated level: SESAR Performance Areas, Performance Indicators, benefit mechanisms, success criteria for validation, definition and use of Baseline and Reference Scenarios, Operating Environments and expected local applicability, interdependencies and assumptions,
  o Maintain the various top-down and bottom-up Influence factors/models
  o Derive and Define the Validation Targets applicable at SESAR solution level from the SES High-Level goals, the Performance Needs (from PJ20) and concept performance expectations derived from the CONOPs. (performance framework in PJ21 and performance needs values in PJ20)
  o Provide support to the PJ19 ATM Design & Integration project to establish a consolidated high level performance view.
• Collect and consolidate the performance assessment of the SESAR projects at aggregated levels, compare them with the SESAR performance targets and perform a gap analysis.
• Support the all R&D projects to produce their Performance Assessment at project level.
  o Support and provide assurance of the application of the relevant harmonized approach (Reference and Guidance Material).
  o Support and provide guidance on performance assessment, ensure the application of standardised assessments
  o Ensure (through audits or else) that all Project level performance assessments are properly conducted and that the results can be used for higher aggregation level assessments.
• For Cost Benefit Analysis (CBA) and Business Cases (BC):
  o Maintain and update the stakeholder CBA models, develop the overall SESAR CBAs and overall BCs to support the ATM-MP business view. This includes providing CBA and Business cases in support of proposals for Deployment Packages and Common Projects. The CBA will use the aggregated performance assessments to estimate the benefits.
  o Support and provide assurance of the application of the harmonized approach.
  o Support projects by providing coherent and consistent CBA data based on standard
  o inputs, coherent assumption management and baseline (scenario) definition.
• More specifically for CBA, BC, Safety, Security, Environment and Human performance
  o Support the project's performance domain experts to enable SESAR 2020 Project performance assessments (i.e. establish community of practice for performance	

domains)
- where necessary provide high level performance assessments for specific domains

- Support and advise the SJU on performance related tasks
    - Provide maturity assessment support and review
    - Advise SJU on progress on SESAR 2020 Project performance assessments
    - Support SJU in structure and terminology of SJU Templates to adequately reflect Performance assessment needs
    - Provide performance cases and performance reports on an aggregated level
    - Provide support to establish an integrated approach between performance management, Master Plan maintenance, ATM architecture, Validation and Verification infrastructure and Release management.

- Support and advise the SJU on regulatory tasks related to performance management including advising the SJU on the content of the review plan to be agreed with EASA and/or National Authorities.

The responsibility of conducting the performance assessments lies with the SESAR 2020 projects. The Reference Material per Key Performance Area is defined beforehand and remains applicable (unchanged) during the SESAR 2020 1st wave.

Maintenance and Evolution of performance assessment tools and potential ad hoc studies (e.g. noise / emission impact assessment) needs to be foreseen and needs to be applicable for the 2nd wave.

Benefit will also be taken of the performance assessments for VLDs: the additional performance data from VLDs will improve the high level SESAR performance assessments, CBAs and Business Cases developed under this project. Where appropriate some extension of existing Reference Material may be carried out to apply it to VLDs to ensure the VLD results are appropriate to these high level performance assessments.

3.23 PJ22 – Validation, Verification and Demonstration Infrastructure

PJ.22	Validation, Verification and Demonstration Infrastructure

Problem Statement

Validation Platforms and Infrastructures, their evolutions and the new capabilities and functions supporting SESAR Validation Exercises (e.g. IBPs for V3, V1/V2 platforms, supporting RTS and FTS, etc.), have to be defined and developed in respecting and optimising system engineering best practices in joined-up coordination with exercises to deliver platforms and tools meeting users' needs

The opportunity for the SESAR Programme is to move forward, building harmonized Validation platforms and infrastructures with common tools making effective use of valuable engineering resources to produce standardised results across a range of IBP infrastructures, obtaining a valuable asset for European Research & Development and Demonstration activities.

Validation platforms and infrastructures shall be able to provide a result easily developed further to be validated and verified on existing ATM Platforms.

High level solution description

The project will not target the industrial development of the validation and demonstration platforms, in particular the development of IBPs is excluded from this activity and it is assumed to be under the responsibility of each SESAR Solutions and VLDs project (e.g. the production of prototypes, industrial tools/mock-ups, IBP engineering artefacts, system integration for VLD). PJ22 should only be responsible for long-term shared developments on the V&V infrastructure, becoming an enabler for future exercises validation activities.

An adequate coordination in each SESAR solution projects will be ensured in order to guarantee integration activities, their coherence and monitoring.

The project is in charge of executing the following processes and activities:

Methodology

Maintain and improve the System Engineering methodologies (defined in SESAR 1) to be applied by the SESAR solution projects to develop V&V Infrastructures (IBPs for V3, V1/V2 platforms, RTS and FTS, etc.).

These communalized methodology and approach ensure that:

- V&V Platforms are developed to properly support the validation objectives of Validation Exercises.
- Engineering process and outputs are harmonized and coherent.
- SESAR solution projects shall align to the agreed methodology and applying it in their activities.

In order to avoid excessive process burden, focus is on the consolidation of the optimised set of methodologies to be made applicable ensuring proper de-risking of platforms development. Tailored principles must be defined to adapt the methodologies to the maturity phase and to the size of Validation Exercises. Tailoring can be referred to the complexity of the validation exercise, to the number of partners involved, prototypes, IBPs involved in the target exercise and will target the production of optimised artefacts in respecting industrial constraints and the SESAR objectives.

Maintenance of V&V platforms catalogue

Maintain the **catalogue of the existing V&V Platforms** documentation providing an overview of the current IBP capabilities and their planned evolution.

Support to system engineering reviews

Contribute to the follow up of the SESAR Validation Exercises life cycle to properly monitor the application of the engineering methodology to the development of V&V Platforms and Infrastructures by the relevant projects.

- Support to the Programme review process through the assessment of the status and readiness for the execution of the Validation Exercises, ensuring the effective implementation and traceability of Platforms against validation requirements.
- Facilitate the qualification of the V&VI solutions in terms of compliance with specific services and

capabilities (e.g. ATG, IOP...), developing the role of a "Solution conformance". The V&VI solution conformance should constitute an opportunity to "recognise" a common tool as defined (or potentially) developed within PJ22 for which there is the adequate level of knowledge.

Support the communalization of validation tools for the long-term

Support the communalization of validation tools and interoperability solutions, for long-term shared developments, and paving the way to Validation Platforms-as-a-Service, when found appropriate. Engineering transversal support to the construction and verification of the V&V Platforms against well-defined set of needs and producing the necessary engineering artefacts (e.g. requirements, architecture, verification and integration plans and reports, ..), in particular respect to the Validation exercises that requires multiple IBPs and for the necessary industrial development/customizations which could be necessary for the V&VP configuration. This activity shall follow PJ 19 guidelines, methodologies and high-level architecture (e.g. ADD/TAD-like).

This should enable (or significantly help):

- The identification and selection for development or enhancement of a set of strategic validation tools and interoperability solution that could increase the SESAR 2020 validation process (supporting several partners and/or several validation needs and also improving cost-efficiency). A coordination and harmonization with the other linked SESAR projects will be secured.
- The possibility to integrate/ use different tools together also enabling the use of existing tools by just adopting them to the standard.
- In addition to IOP solutions, to which a special focus will be done, the following communalized validation tools could be considered (not exhaustive list): enhancement of existing Fast-Time Simulators to adapt them to the needs of the new SESAR operational concept, development of data mining tools to support the analysis of validation data, adaptation or development of validation tools that support the performance assessment of the operational concept, common data preparation tool supporting the definition of an IOP area shared adaptation, common tools for simulating IOP-enabled external stakeholders.

Note that, in this context, "validation tools" are those software products that either emulate the capabilities of an operational system through simplified behavioural modelling or complement pre-operational system capabilities in order to build a complete V&V Platform.

Appendix C High-Level Definitions of Work – VLDs

1 Introduction

The following section presents the High Level Definitions of Work (DOW) for each project in terms of Demonstration overview, Justification against prioritization criteria and is complementarity with the earlier parts of the Programme.

2 Project Descriptions

2.1 PJ23 – Multi FAB Free Routing

PJ.23: Multi FAB Free Routing within low to high complexity environments with full support of optimised descent profiles (WAVE 1)
Demonstration Overview
• Providing the airspace user with the highest possible degree of freedom in flight planning in order to allow for highly efficient flight routings is one of the main focus areas of the SESAR Program. This is captured in the PCP as ATM Functionality 3,Free Route and Flexible Airspace Management, which may include elements of airspace configuration, airspace allocation and flexible sectorisation. The ATM functionality mainly addresses the implementation of: o Direct Routing Airspace, which offers either dedicated direct routing options published in RAD App 4 or the ability to plan DCT direct routings between arbitrary entry and exit points; o Free Routing Airspace, which offers the ability to freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability; o MTCD in Free Route operations, to assist the ATCO to control off-route flights keeping the awareness and safety level as high as possible; and o FDP systems improvement focused on Free Route airspace management and data sharing. Free Routing Airspace (FRA) availability may be subject to traffic demand and/or time constraints. FRA shall have a defined Volume of Interest with lateral, vertical and, if necessary, temporal limits. Where FRA is established only between published hours, a fixed-route network and/or direct routing options shall remain established for those times when FRA is not active. It has to be noted that due to complexity and traffic density in certain areas, the provision of “classic” ATS routes shall also remain an option for the ANSP in order to ensure high capacity and safety in those high-density areas. For the time being, Free Route abilities are offered in different capability levels (Direct Routing Airspace and Free Routing Airspace) wherever and whenever possible. However, its operational availability is strongly influenced by the relevant airspace reserved for military operations. For an increased availability of such airspace, information between civil and military stakeholders needs to be enhanced and seen as an integrated scenario in which all the relevant information related to dynamic use of airspace, 4D trajectories, airspace management and military needs, are shared and integrated in the deconflicting systems. As ATM functionality #3 primarily addresses horizontal flight efficiency, it has to be taken into account that inefficient descent profiles, in particular the so-called “Early Descent” - where the descent has to start far ahead of the Top of Descent - may bring a stronger penalty for the AUs than some route extension. Continuous Descent Operations (CDO) provide high potentials for optimizing vertical flight efficiency. However, especially in high-density environments, a proper balance has to be found between the efficiency of individual flights on the one side and the airspace capacity necessary for arrival and departure flows on the other. In order to achieve this balance the link to advanced Arrival Management Systems (AMAN), in particular with extended horizon (reference to PCP ATM functionality #1), supports the realisation of CDO, especially considering optimal CDOs starting from Top of descent. • The demonstration will follow an incremental approach, starting from a low level of complexity to be gradually increased, moving from direct routing involving a single ANSP

(as example:city pairs) during a specified period of time with low traffic conditions, towards Free Route exercises involving more ANSPs and FABs.

- The difficulties should be considered in terms of ANSPs and FABs involved, and in terms of time-frame (intended as daily and seasonally time frame) .
- In the framework of multilateral projects (FRAMaK) and on FAB level (FABEC FRA), DFS achieved significant performance benefits regarding the implementation of Direct Route capabilities and local CDO implementations. DK/SE FAB has already implemented Free Route Airspace and ongoing work ensures that NEFAB and UK/Ireland will follow shortly. NEFAB and DK/SE FAB will operate a united concept from 2015. The next step in the context of Very Large Scale activities would be to fan out the Free Route concept across multiple FABs in Europe, while adapting the concept in terms of capability levels to local / regional characteristics, and to provide optimized connectivity of the European Free Routing Airspace with subjacent airspace structures by offering Continuous Descent Operations wherever and whenever possible.
- WE-FREE is also a recent sample of a DEMO (cfr. 01.09 in the frame of CFT-LC-070, 2012) that aimed at optimizing the lateral dimension as well as the vertical one for flights departing from Paris CDG airport, and having a destination in Italy during weekend operations.
- Demonstration of Free Routing Airspace in Europe providing H24/D7 support of:
  - Direct Route exercises in low-medium complexity context
  - Free Route exercises in low-medium complexity context

  These offer the ability to freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability.

  Elements of flexible airspace management should be included, especially:
  - advanced AMC coordination taking into stakeholders' needs for effective mission and flight planning respectively;
  - enhanced data exchange mechanisms with regard to airspace status (current and forecast);
  - solutions for in-flight FPL re-filing;
  - DCB based on flexible airspace structures like e.g. DMA;
  - Flow Management tools supporting DCB and mitigation actions for short- and medium-term flow changes due to unplanned airspace activation; and
  - Controller tools ensuring efficient tactical rerouting in case of ad-hoc airspace activation.

Justification against prioritization criteria

Significant contribution to performance expected

- Performance Expected as assessed as part of V1-V3 results
  - Improved Flight Efficiency
  - Improved Environmental Sustainability
  - Improved Predictability
- Public Live Trials will offer publicly available routing options and are open for many stakeholders. The demonstration will provide results based on real-life daily operations. The demonstration shall fully validate the feasibility of the concept of Operation in view of a

later implementation.

- As mentioned above, the incremental approach will gradually add complexity, from direct routes in low traffic conditions, to Free Route in medium traffic conditions: every benefit in terms of confidence and performance, will follow the same parallel road.

Maturity

The required OI Steps and the assumed V3 forecast dates are:

- AOM-0501, Step1: Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments. V3 forecast date: SESAR 2014-2016.
- AOM-0702-A, Step 1: Continuous Descent Operations (CDO). V3 forecast date: SESAR 2014-2016.
- AOM-0202-A, Step 1: Automated Support for strategic, pre-tactical and tactical Civil-Military Coordination in Airspace Management (ASM). V3 forecast date: SESAR 2014-2016.
- AOM-0206-A, Step 1: Flexible Military Airspace Structures in Step 1. V3 forecast date: SESAR 2014-2016.
- CM-0205, Step 1: Conflict Detection and Resolution in En Route using trajectory data in Predefined and User Preferred Routes environments. V3 forecast date: SESAR 2014-2016.

Need for coordination at European/Global level

- See above; demonstration is envisaged with participation of multiple FABs (multiple ANSPs) across a large area.
- The G/G and A/G integration will be necessary to connect the ANSPs different HMI and FDP systems (SWIM).
- As stated above, demonstration will address cross-FAB operations requiring G/G capabilities. With regard to A-AFUA and opportunities for in-flight FPL refiling; also A/G aspects are addressed.
- The demonstrations will show the possibility of a more flexible and dynamic airspace management, increasing flight efficiency and predictability starting from the flight planning level, achieved also by a more frequent update of the airspace configuration; available routes and portions of airspace can be negotiated between all the stakeholders involved, and communicated to all interested parties.

Complementarity with the Programme

Related Strategic Priority Business Needs (SPBN)

☐ Airport Integration and throughput	☒ Traffic Synchronisation
☒ Conflict Management and automation	☒ CNS/SWIM
☒ Moving from Airspace to 4D Trajectory Management	☒ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)

- OFA02.01.01 Optimised 2D/3D Routes
- OFA03.01.03 Free Routing

Related Operational Improvement Steps (OIs)	
• AOM-0501 • AOM-0702-A • AOM-0202-A • AOM-0206-A • CM-0205	
Related PCP ATM Functionality (if applicable)	
☒ AF1: Extended AMAN and PBN in high density TMAs	☒ AF4: Network Collaborative Management
☐ AF2: Airport Integration and Throughput	☒ AF5: iSWIM
☒ AF3: Flexible Airspace Management and Free Route	☒ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)

2.2 PJ24 – Network collaborative management

PJ.24: Network collaborative management
Demonstration Overview

Time-Based operations requires the Network Operations plan (NOP), elaborated in the planning phase, to focus on the optimum use of the ATM network. The NOP is implemented in the execution phase. This requires that the quality of the Network Operations Plan is high enough to represent accurately the airspace users' needs and the Airspace Providers availabilities. The concept requires, as well, that the plan is properly distributed to the ATM stakeholders involved in executing the plan. If the plan needs to be updated during the execution phase, the modification is coordinated with all relevant actors up to the end of the flight. The *Network collaborative management* VLD is addressing these different requirements within Step 1 of the SESAR Concept. This VLD addresses Dynamic Demand/Capacity Balancing business needs. It will demonstrate that the process for managing traffic complexity delivers both network and local benefits in the Cost Effectiveness, Fuel Efficiency, Capacity and Safety areas. Through better workload distribution and the reduction of traffic peaks by the implementation of STAM measures, balance between demand and capacity will be ensured. **The Wave 1 VLD (1-2) will predominantly, focus on measures applied to flights in the pre-departure phase (before the start of the flight execution).** The VLD will support Airspace Users, Airport Operators and ANSPs in meeting their business objectives by increasing cost-efficiency through improved network performance, notably capacity and flight efficiency.

The Network collaborative management VLD will rely on the following elements:

- Enhanced DCB procedures between all actors involved in Network Operations (ANSPs, Airports, Airspace Users, Network Manager) supported by automated tools for Advanced ATFCM measures (local hotspot detections assessed in the network view, elaboration and promulgation of STAM measures including CDM, implementation and monitoring of these measures).
- Complexity and Capacity solutions supported by local DCB tools using SWIM Services to interconnect these tools and NM system, allowing local actors (organised around the Integrated Network management and extended ATC Planning – INAP) to identify and manage hotspots.

The demonstration will focus on the following aspects that implement a set of enhanced DCB procedures supported by automated tools:

- Hotspot detection through the use of an automated tool set that is able to assess workload impact and identify hotspots in en-route sectors and at airports. The efficiency of the implemented solutions to previously identified hotspots will be continuously monitored, within the network view, providing tactical feedback when the outcome of a solution differs from the expected one.
- Identification of the DCB measure (STAM) that better addresses the hotspot according to the hotspot specific characteristics (i.e. complexity, occupancy rate, confidence or severity). In line with the STAM concept of operations, an analysis of the situation will be performed by the initiator of the measure to support the identification of a solution from the available DCB toolbox.
- Reconciliation of multiple local DCB constraints. To this end, the potential solution will be coordinated and disseminated to the different stakeholders (supported by the Network CDM Information Platform and within the context of the NOP) at the Local and Network levels. Once coherence and agreement is achieved, the implementation will be initiated. The actions that the specific measure requires will be promulgated to the appropriate actors and the implementation is finally achieved.

- **In wave 1 CDM will include at minimum partners directly involved by the measure (ANSP or Airport initiating the measure, adjacent ANSPs, destination Airport, Airline concerned).**

Local DCB tools will use SWIM Services to interconnect the local tools and NM system. This demonstration will focus on how the local DCB unit uses the available DCB toolbox to identify the adequate measure to be taken to address a hotspot. The tool box will include at least the following measure types:

- Time modification: measures modifying the timing of the flight trajectory i.e. every measure that leads to the calculation of a TTO, TTA or CTOT constraint. This includes measures such as MDI (Minimum Departure Interval), TONB (Take-Off Not Before) etc
- Trajectory modification: measures modifying the 3D trajectory of the SBT, i.e. rerouting and flight level capping measures.
- Capacity Measures: the aim of this improvement is to elaborate the complete DCB measure that includes Dynamic Airspace Configurations combined with 4D constraints to optimally adapt the capacity to the demand and minimize demand adjustments taking into account cost effectiveness and flight efficiency.
- Enhanced DCB procedures supported by automated tools for Advanced ATFCM measures (hot spot detections, promulgation and implementation of advanced short term ATFCM measures including Collaborative Decision Making).

4D trajectory profiles will be processed and distributed to the Local and NM systems with high accuracy and predictability, covering the airspace of all EUROCONTROL member states and beyond if deemed necessary. Accurate shared 4D trajectory profiles will provide a common view on planned trajectories to the various Stakeholders who will be using that common information for different purposes, as they need, for fulfilling their own responsibilities. During Short-Term and Tactical planning, end-to-end trajectories are re-computed until the execution of the flight is finished. This VLD will demonstrate the readiness of the participants to apply advanced DCB procedures involving Network Management functions (NMf) and ATC actors in an interoperable environment, closing the gap between the planning and execution phases. A number of local INAP actors (min. 5 ANSPs in the core area) will be able to apply the full set of DCB toolset via SWIM, involving hotspot management and STAM measure coordination and implementation. The DCB scenarios prepared for the trial will include flow management measures (departure and arrival) related to at least 3 major Airports. A number of Airlines (Min. 10) operating in this area will be involved in the trial. These Airlines should have the possibility to rely on extended flight planning features to communicate their intentions (either via their own or via supporting CFSP planning tools).

The VLD will be performed in two phases:

- Live traffic verification: using shadow mode.
- Initial deployment: Live Trials.

Justification against prioritization criteria

Significant contribution to performance expected

Benefits will be delivered through:

- Increasing and better using existing Network capacity through dynamic sectorisation, smoothing peaks in demand and reducing complexity, thus allowing more consistent use of Network capacity.
- Improving predictability through increased sharing in the flight trajectory, as an essential enabler to efficiency, capacity and safety.

- Improving flight efficiency by limiting ATC constraints on optimum flight profiles (only when required), thus reducing fuel burn, noise and CO2 emissions.
- Enhancing flexibility and therefore improving the management of expected/unexpected traffic demand/capacity imbalances.

The V1-V3 exercises performed as part of OFA05.03.04 have already shown that the implementation of a limited version of the toolset should be able to provide a 10% reduction on the number of saturation periods and a 10% sector capacity increase. The initial V3 trial (refer. 3-day live validation exercise between 8 and 10 November 2011) showed the following:

- Hotspot detection based on Occupancy Counts instead of Entry Counts results in 90% of cases in doing nothing because the complexity is sustainable for the ATC position.
- In Reims and MUAC ACC, a significant reduction of delays (more than 50%) is observed due to the implementation of occupancy counts and STAM.

The STAM V3 trials will provide results for a larger number of participants and will confirm the first assessments from the initial trials. The *Network collaborative management* VLD should confirm these validations in an operational environment that includes several Local Network Management Functions and the Network Manager. The VLD should increase the confidence in the expected benefits whilst providing additional information regarding the potential operational usage and expected costs to all stakeholders. Enhanced DCB procedures aim at applying specific measures to a limited number of flights instead of global measures to traffic flows. An important validation element to consider before full deployment of these new procedures is to assess, through Flow Manager/Local Traffic Manager expertise and local tools, at what level of congestion specific measures cease to be efficient and need to be replaced by flow measures. This cannot be validated at V3 level.

Maturity

VP522: Dynamic DCB (STAM) – Release 4, VP700: Advanced STAM interfacing local tools - Release 5, VP749: TTO/TTA Management – Release 6, VP713: EFPL exchange through B2B services - Release 5.

These V3 trials will address some of the features targeted in the *Network collaborative management* VLD but they are only partial building blocks: VP522 and VP749 will validate the STAM measures without relying, or relying only partly, on interoperability; VP700 will allow local INAP actors to set-up the interoperability but it is expected that the full set of STAM functions will not be developed by all partners. VP713 will focus on the flight planning aspects without assessing the impact on the whole DCB process.

The VLD should confirm these validations in an operational environment that includes several Local Network Management Functions and the Network Manager and should increase the confidence in the expected benefits whilst providing additional information regarding the potential operational usage and the impact on critical staff workload.

Need for coordination at European/Global level

The essence of enhanced DCB procedures is to allow local actors to manage issues in a global context, ensuring the proposed measures are properly assessed in a network view and are properly coordinated with all actors concerned. They can only provide the expected benefits when a large number of actors are using them. A common view on planned trajectories amongst various stakeholders is an enabler for high quality ATM planning across the entire European Network, in line with the SESAR Trajectory-Based operations concepts. To obtain the full benefit and to successfully implement the STAM measures requires that all involved actors are fully coordinated and informed, and that all constraints are coherent both at flight and local/regional level. To achieve this goal they must be coordinated among the different participants in the process. This implies the need to perform an exercise that includes several ANPS, airlines, airports and the

Network Manager. The proposed operational environment will include both En-Route (Very High, High and Medium ACCs according to C2 ACCs Classification]) and TMA (Very High, High and Medium TMAs according to C2 TMAs Classification) areas.
Complementarity with the Programme
Related Strategic Priority Business Needs (SPBN)
☒ Airport Integration and throughput / ☐ Traffic Synchronisation
☐ Conflict Management and automation / ☐ CNS/SWIM
☒ Moving from Airspace to 4D Trajectory Management / ☒ Network Collaborative Management and Dynamic/Capacity Balancing
Related Operational Focus Areas (OFAs)
• OFA05.03.04 Enhanced ATFCM processes • OFA05.03.07 Network Operations Planning • OFA04.01.01 Integrated Arrival/Departure Management at Airports • ENB02.01.01 SWIM
Related Operational Improvement Steps (OIs)
The three essential OIs that will be ready by the end of the SESAR programme are: • CM-0103-A (Automated Support for Traffic Complexity Assessment), • DCB-0208 (DCB in a trajectory management context), and • DCB-0308 (Advanced Short Term ATFCM). • AUO-0203-A (Extended Flight Plan)
Related PCP ATM Functionality (if applicable)
☐ AF1: Extended AMAN and PBN in high density TMAs / ☒ AF4: Network Collaborative Management
☒ AF2: Airport Integration and Throughput / ☒ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route / ☒ AF6: Initial Trajectory Information Sharing
Wave
☒ Wave 1 (2016-2018) / ☐ Wave 2 (2019-2021)

2.3 PJ25 – Extended AMAN

PJ.25: Extended AMAN
Demonstration Overview
Extended AMAN Context An extended AMAN horizon provides the ability to help deliver aircraft to the TMA in a smoother, more optimised sequence. The greater the range of the horizon, the greater the amount of delay that can be absorbed, or the smaller the speed change needs to be. However, the further the horizon becomes, the greater the instability due to in-horizon departures. Furthermore, in current operations, the data used by the extended AMAN process is often too inaccurate to permit the full optimisation benefit to be achieved. Therefore much of the focus of current Extended AMAN development is to transfer delay out of the destination TMA and upstream to the en route phase as linear holding. Extended AMAN also permits some smoothing of the arrival stream to try to reduce the peaks and troughs in the numbers of aircraft arriving at any one time. It is expected that as the accuracy of data used by the Extended AMAN process improves, the focus will start to move towards optimising the arrival order. In some current AMAN operations, information is passed to upstream sectors so that controllers can pass voice instructions to the aircraft in question, either as a speed change or information based upon time-to-lose/gain (TTL/G). SESAR is conducting validation into the use of execution phase constraints such as Controlled Time of Arrival (CTA) where aircraft are required to meet the constraint time at an arrival point within specified accuracy and this seems suitable where an optimised arrival order is required. However, this introduces considerable complexity in denser traffic areas, where controllers often use speed control to solve separation problems, thereby preventing the aircraft from meeting its CTA. In these circumstances, where the focus is on linear holding and arrival stream smoothing, execution phase arrival management constraints can still be calculated by extended AMAN and passed to aircraft but these may be ssuperseded by any separation management instructions. An aircraft that has received an ATC clearance to ensure separation will no longer be required to adhere to its arrival management constraint.. This arrival constraint, which may be in the form of a speed instruction, TTL/G, or a specific time will usually be to a pre-descent point, intermediate descent point or Initial Approach Fix but can be to any suitable point. The constraint is frequently linked with systemised airspace defined using an appropriate Performance Based Navigation standard. Wave 1 Extended AMAN Very Large Scale Demonstration Objectives This Wave 1 VLD is focused on demonstrating how arrival constraints can be passed to aircraft and the subsequent processes required for aircraft to meet them. The VLD objectives are likely to include the following: 1. Provision of arrival constraint by an extended AMAN process to airborne aircraft. The arrival constraint will be for an appropriate arrival point which may be linked to systemised airspace defined as an appropriate PBN standard. 2. Passing arrival constraints to two or more upstream ANSPs to demonstrate how aircraft can meet the constraint, and the technical and operational issues regarding the aircraft and ANSPs associated with this process. 3. Demonstration of data sharing between participating ANSPs and aircraft with regard to input data to AMAN (usually aircraft ETA), and output data from AMAN in the form of suitable arrival constraints.

Demonstration Approach

To meet the demonstration objectives a number of different stakeholders will be required, including:

- A suitable number of participating airlines.
- A suitable number of airports, including major airports relying on arrival management techniques and where demand is >90% of their operational capacity. The majority of participating airlines should use the participating airports.
- A suitable number of ANSPs, including those responsible for the airspace surrounding participating airports, and where at least two ANSPs provide an upstream ATC service to the destination airport.

The arrival sequencing will be supported by local XMAN/AMAN tools using SWIM Services to interconnect these tools between participating ANSPs.

Justification against prioritization criteria

Significant contribution to performance expected

The demonstration will examine the benefits in terms of reduced fuel consumption, reduced environmental footprint, enhanced efficiency, controller workload impact and sector capacity

Other benefits include:

- Reduced TMA holding at destination.
- Reduced level of peaks and troughs of arrival flow and consequent reduction in peak level controller workload.
- Enhanced flight efficiency by allowing optimum descent profiles beyond the terminal areas
- Reduced need to use ATFM regulations to manage arrival capacity.
- Enhanced network performance by reducing/removing impact of measures addressing arrival sequencing on network operations.

Structured by KPA, benefits include:

PREDICTABILITY: adherence to the arrival constraint.

CAPACITY: while these measures are unlikely to improve capacity, better and smoother management of the traffic is likely to reduce the need to intervene with ATFM measures that can reduce capacity overall.

ENVIRONMENT: these measures will reduce aircraft fuel burn through taking delay in the more efficient en route and slower descent phases, also providing environmental improvements.

EFFICIENCY: improved use of arrival management constraints enables aircraft crews to plan their flight better, enabling more efficient flight speeds in en route and during the descent, with reduced holding at destination TMA.

Evidence:

- Extended AMAN benefits identified in Project 5.6.4 and 5.6.7.
- Use of systemised airspace benefits identified in 5.7.4, 5.6.3 and 6.8.5
- PCP Benefit Analysis: Fuel reduction, delay reduction

The focus is on extending work carried out by existing projects and trials such as the Heathrow XMAN trial to include more upstream ANSPs. This will permit new subjects to be demonstrated such as apportionment of delay between ANSPs and responsibility for meeting the arrival constraint (aircraft and/or controllers).

Demonstration of data sharing using SWIM will be an important part of this VLD, including both the aircraft unadjusted ETA data used to calculate arrival constraints, and in the AMAN-output data, i.e. the arrival constraint, and how this is passed to the pilot.

Maturity

Assumed V3 Target Dates of Each Solution

- Extended AMAN V3: 2014
- RNP1 SIDs/STARs V3: 20??

Assumed OIs

- Extended AMAN V3: TS-0305-A
- RNP1 SIDs/STARs V3: AOM-0404, AOM-0603

This demonstration will focus on the integration of a range of concepts developed individually within SESAR1. These projects include the following.

- VP244bis demonstrated the benefits of passing Heathrow arrival constraints to Shannon controllers in terms of aircraft fuel and environmental emissions reductions.
- VP 695 is a V3 Live Trial in Reims UAC for London Heathrow arrivals to evaluate the use of the Heathrow Extended AMAN horizon for cross border arrival management, which was itself developed in VP244.

This VLD will go significantly beyond these individual activities by showing how very-large scale demonstration across a geographically widespread range of different stakeholders can achieve the benefits anticipated by SESAR for these particular concepts.

Need for coordination at European/Global level

The nature of extended AMAN demonstrations implies that many stakeholders must be involved, simply because the horizon range includes a number of stakeholders. The current London Heathrow XMAN trial for example, requires the participation of the the IAA, DSNA, Maastricht, NATS and many airlines. For this demonstration the number of stakeholders increases, both numerically and by different type of stakeholder. As these processes affect so many stakeholders, standardized procedures are required across Europe. The concept requires aircraft and ANSPs to behave in a similar way, following similar procedures, irrespective of the departure or destination airports.

This VLD will require G/G integration to connect the systems of participating ANSPs with each other, and eventually with the systems of participating airports and the Network Manager. This will be achieved though SWIM.

COMPLEMENTARITY WITH THE PROGRAMME

Related Strategic Priority Business Needs (SPBN)

☒ Airport Integration and throughput	☒ Traffic Synchronisation
☐ Conflict Management and automation	☒ CNS/SWIM
☒ Moving from Airspace to 4D Trajectory Management	☐ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)	
• OFA 04.01.01 - Integrated Arrival/Departure Management at Airports • OFA 04.01.02 – Enhanced Arrival and Departure Management in the TMA and En-route	
Related Operational Improvement Steps (OIs)	
• TS-0305-A • AOM-0404 • AOM-0603	
Related PCP ATM Functionality (if applicable)	
☒ AF1: Extended AMAN and PBN in high density TMAs	☐ AF4: Network Collaborative Management
☒ AF2: Airport Integration and Throughput	☒ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☒ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)

2.4 PJ26 – Performance Based Navigation (PBN)

PJ.26: AF1 PBN and GNSS (Wave 1)

Demonstration Overview

Objective : Testing and deploying different PBN and GNSS procedures on various operational environment will enable wide-scale data collection to get confidence in new technologies and incentive aircraft equipage and generalisation of these procedures. The main improvement that will be addressed in Wave 1 will be in the area of RNP1 and GBAS/SBAS new capabilities.

RNP1 SIDs and STARS procedures are part of the PCP. It is particularly important to take due account of RNP 1 reversion issues, where needed. RNP AR will also be needed on a case by case basis for environmental or terrain reasons. RNP1 route and free route may also be used to support definition of new route used for direct routing. Planned demonstration will start by identifying a list of airport candidates for RNP1 or RNP AR procedures requiring a demonstration phase which should be carefully distinguished from the deployment phase. Following criteria could be used: demonstration for a limited duration with an identified set of flights prior to full operational procedure publication.

Current operations using GBAS or SBAS technology are based on 'ILS look a-like' procedures. The SESAR BAFO III project (P 6.8.8) aims to validate new approach procedures that are made possible by the GBAS technology but are not capable of being flown today. SBAS can offer similar performance without any additional infrastructure on the ground. Use of GBAS catII/III capable ground stations as validated in project 15.3.6 would provide experience for future implementation of GBAS catII/III which is the main objective of GBAS.

These GBAS/SBAS demonstrations aim to demonstrate the full capability of GBAS Cat 1 or SBAS based on the mature concepts developed in SESAR 1. The following CAT 1 capabilities are expected to be included:

- Steeper approaches (up to 3.5 degrees or as assessed as safe within Project 6.8.8). Steeper approaches may consist of segments with different glide slope angles or could be steeper to touch down
- RNP-to-GLS including RF-legs.
- Adaptive displace thresholds

All these advanced capabilities need to be well integrated with arrival management, as experience has shown that integration of mixed equipped traffic is often challenging.

Near CatIII operations are also envisaged for business aircraft using SBAS and Enhanced Vision Systems. Demonstrations can be expected in this area as well.

Operational Environment:

AIRPORT: Small, Medium and large airports are potential candidates for new cat 1 capabilities. Participating airports may have GBAS Cat I technology deployed or will use existing SBAS EGNOS system. Across the group of participating airports all of the Cat I capabilities must be demonstrated using live flights (i.e. one airport may demonstrate curved approaches, while a second airport demonstrates steeper approaches). Live flights can be special demonstration flights or standard scheduled operations with GBAS Cat I or SBAS capable aircraft.

TMA: RNP1 or RN-AR procedures will be defined according to local TMA environment.

AIRSPACE USER: live flights from business aviation or airlines using aircraft equipped with GBAS Cat I or SBAS technology.

REGULATORS: will need to be involved in regards to the operational use of these new technologies/procedures for demonstration purpose and to provide input to support standardisation of future regulations affecting deployment across Europe.

Justification against prioritization criteria
Significant contribution to performance expected
Noise is a key issue for a lot of airports and demonstration of technology/procedures that allow for same capacity by smaller noise profile will be of interest for many airports. GBAS or SBAS provide the potential performances that enable these new capabilities and procedures. GBAS Cat I is the initial deployment of the GBAS functionality. Simulation trials with P 6.8.5 of the SESAR program have shown positive performance outcomes, however results from live flights using GBAS Cat I have only been performed on a small scale due to very few completed deployments at airports. Airports are unwilling to invest in deploying GBAS technology when it is unregulated and there is a very low equipage on existing aircraft. Similarly AU's are unwilling to invest in equipping aircraft when GBAS use is unregulated and there are very few airports deploying the functionality. Project 6.8.8 as defined in BAFO III will validate some additional GBAS Cat 1 functionality with the expectation that this functionality will address a critical business need for airports around reduction of noise. Demonstrating this local airport benefit will generate confidence amongst: • European Airports in regards to the benefits/business case locally • Airspace Users, because with the deployment of the ground equipment and availability of GBAS and SBAS procedures at a few European Airports, their investment in airborne equipment is more viable • Regulators with the demonstrated safety of the Cat I technology, and Cat I design guidelines. Regulation for Cat II/III functionality is expected to require extensive use of the Cat I capability in order to provide the necessary confidence in the safe operation of the technology. It is foreseen that the greatest performance benefits will come from the CAT II/III functionality however due to the cost of deployment and the long lead time for regulation supporting the operational use of this technology the proposed demonstration will encourage airports and airspace users to include GBAS in their future equipage plan. SBAS ILS look a-like procedures have already been deployed in a number of European airports and will replace some ILS on some regional airports in some countries (eg France). It is also currently facing some limitation in terms of fleet equipage; good progress is observed in business aviation, while some new commercial aircraft will be equipped soon. Potential benefits can also be expected with curved approach, steeper approach and adaptive displaced thresholds on a case by case basis.
Maturity
OFA 02.02.04 Approach Procedures with Vertical Guidance • EXE-166 – Validation of RNP to GLS Flight Simulation – R3 • EXE-05.06.03- VP-483 Enhanced Terminal operations based on automated RNP transition to LPV thanks to improved flight procedures and upgraded avionics support for regional airplane, AOM-0605 : Enhanced Terminal operations with automatic RNP transition to XLS/LPV . – R4 Steeper approaches and Adaptive displaced thresholds are considered within AO-0308 (Optimized Wake Vortex Separations using Differentiated Glide Paths and Displaced Touch Down Zone) and, even if they are going to be assessed within Project 6.08.08, according to the feedback from project 15, this OI step would require further validation work in SESAR 2020 to fully achieve End of V3.

Need for coordination at European/Global level

PBN and GNSS require synchronisation of airborne capabilities with procedures defined by ANSP. High confidence in the performance and maturity is required to confirm their respective implementation plans.

A GBAS deployment involves the:

- local Airport and ANSP to deploy the ground station and design the approach routes
- the national regulator to approve the use of the approach paths and technology in the live operation.
- Airspace Users with GBAS capable aircraft.

As this demonstration requires the demonstration of the full Cat I GBAS Capability with the expectation that no one airport will want to/need to operate all the functionalities, then this demonstration will also require coordination across a number of European airports that are deploying GBAS Cat I.

New advanced SBAS procedure and RNP procedures involves :

- ANSP to define, design and publish new routes and procedures
- National regulator to approve the use of these procedures and technology in the live operation.
- Airspace Users with SBAS or RNP compliant capable aircraft.

COMPLEMENTARITY WITH THE PROGRAMME

Related Strategic Priority Business Needs (SPBN)

☒ Airport Integration and throughput	☒Traffic Synchronisation
☐ Conflict Management and automation	☒ CNS/SWIM
☒ Moving from Airspace to 4D Trajectory Management	☐ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)

- OFA 01.01.01 LVPs using GBAS
- OFA 02.02.04 Approach Procedures with Vertical Guidance
- OFA 01.03.01 Enhanced Runway Throughput

Related Operational Improvement Steps (OIs)

- AOM-0603
- AOM-0404
- AOM-0605
- AO-0308

Related PCP ATM Functionality (if applicable)	
☒ AF1: Extended AMAN and PBN in high density TMAs	☐ AF4: Network Collaborative Management
☒ AF2: Airport Integration and Throughput	☐ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☐ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)

2.5 PJ27 – Flight Object Interoperability

PJ.27: Flight Object Interoperability
Demonstration Overview

The VLD project covers both Flight Object Interoperability within the European boundaries (A), as well as the interoperability of European systems with non-European systems (B).

A) Flight Object Interoperability within core Europe

This part of the Flight Object Interoperability VLD project will be a means to support the deployment of FO-IOP equipped ACCs in core Europe. It depends on the FO-IOP results from EUROCAE ED-133 standardisation update *(ED-133 v2 is expected to support PCP deployment),* SESAR interoperability validation and A6 FDP industrialisation works, which all are expected to be available at the beginning of 2017.

It is the objective to ensure that FO-IOP works in the real operational environment of several ACCs, thus demonstrating it is sufficiently reliable, meets performance expectations and supports the ACCs daily operational functions and procedures. This includes demonstrating the correct implementation of blue and yellow SWIM profiles. Furthermore it will be demonstrated that FO-IOP can be used without compatibility problems with other ATM functions, such as OLDI. This is a very important deployment aspect, because FO-IOP and OLDI are expected to co-exist in operational service for a very long transition period.

To cover all objectives requires **several VLD steps** within the Wave 1 and Wave 2 timeframes. The functional and geographical scope of these VLD steps will grow in 3 defined steps as follows:

1. Demonstrate FO-IOP works in upper airspace ACCs, supporting standard coordination and transfer functions during execution flight phase.
2. Demonstrate FO-IOP works already during the pre-flight phase by adding the Network Manager where he will assume the role to manage/publish the Flight Objects during the pre-flight phase.
3. Demonstrate FO-IOP works also in lower airspace by adding more ACCs and eventually by adding FO-IOP functionality (e.g. EPP, What-if, etc)

The VLD will be executed in a real operational environment with a direct impact on air traffic. Hence it is necessary to include all safety-related activities, to assure there will be no adverse impact on, or risk introduced to air traffic.

The VLD will use the methods “Shadow Mode” and “Live Trials”, in that order, for each of the 3 VLD steps described above.

1. Shadow Mode will verify that FO-IOP equipped ACCs can process all live traffic information such as radar-data, flight plan data, aeronautical data, MET data etc, with sufficient performance and stability, but without direct impact on air traffic. Typically the shadow mode could be executed on an operational ATM system in test mission mode.
2. Live Trials will demonstrate that FO-IOP equipped ACCs can operate without any restrictions. The trials could be performed during periods of low traffic density such as night hours and weekends and avoiding peak traffic periods during summer schedule. Typically the live trials will be executed on an operational ATM system in operational mission mode. Alternatively it is possible to use a different ATM system provided it has passed the safety assessments.

The VLD proposes 6 activities, of which the following are in scope for wave 1:

1. Shadow Mode IOP VLD Phase 1 in upper airspace.
2. Preparation for Live Trials IOP VLD Phase 1.
3. Preparation for Shadow Mode IOP VLD Phase 2 adding the Network Manager .

This branch of the FO IOP VLD project will demonstrate that the FO-IOP functions can be deployed by a strategy of stepwise implementation where early deployment steps will define the start conditions for subsequent deployment steps. This will enable the introduction of FO-IOP into pan-European airspace in stages by starting with high traffic density areas first and then rolling it out according to a coordinated and synchronised deployment roadmap. This is considered the most successful FO-IOP deployment strategy.

The following changes need to be implemented by all involved ATM systems:

1. Integration of a Flight Object component.
2. Integration of SWIM services to exchange flight object information and to receive MET and environmental data.
3. Processing of common and synchronised Meteorological data, Aeronautical data, Airspace Structure data and Aircraft performance data via ‘yellow-profile’ web-based SWIM services.

It is assumed that a mature SWIM infrastructure will be created for this VLD.

With the current VLD the Flight Object Interoperability will be demonstrated. In Branch B of this VLD project, described below, the Extended AMAN VLD and the Initial Trajectory Sharing VLD have already been identified to also use FO / IOP.

The works and results from this VLD are an input and prerequisite to the Flight Object Interoperability VLD during Wave 2.

B) Flight Object Interoperability with non-European systems

It is one of the main SESAR objectives that European ATM solutions are applicable beyond European boundaries and that European systems are able to interoperate with other ones. This part of the Flight Object Interoperability VLD project aims to demonstrate that FO described in Europe could be shared with systems from other Regions out of Europe and with Airlines operation Centres.

This Demonstration addresses the sharing of information between European and American (North and South)/Atlantic oceanic systems in order to demonstrate not only its feasibility but also the benefits that the sharing of information produces on aspects such as flight predictability, silent coordination, etc. If not all the systems along the flight path are appropriately equipped for IOP, this demonstration will also demonstrate mechanisms for covering the gaps, based on any or a combination of the following: the IOP functionality and the support from Airspace Users (through any of both, download of flight intentions from aircraft (via EPP when available), or information sharing with AOC).

Different demonstrations exercises shall be performed for addressing the different boundaries to be covered:

1. North Atlantic: for covering the traffic flow from/to North America via Shanwick and Santa Maria Oceanic centres.
2. South Atlantic: For covering the traffic flow from/to South America via Canarias and Santa Maria Oceanic Centres.

Several instantiations of the above will be repeated by increasing the scope, in order to finally achieve the required level of IOP in a stepwise approach. **Wave 1** should focus on extending the geographical scope of iCATS for covering additional boundaries in North Atlantic Area, and to start demonstrations in the South Atlantic Area.

Justification against prioritization criteria

Significant contribution to performance expected

Branch A of this Flight Object Interoperability project focusses mainly on the preparation of the deployment of FO-IOP functionality into ACCs of core Europe. This deployment is considered a key enabler to introduce more advanced 4D-trajectory management functions into those ACCs and will have an indirect positive effect on ATCO productivity. With the FO-IOP a significant reduction of inconsistent flight data information between the involved ACCs is expected. This will cause a workload reduction to execute error correction due to inconsistent information. Furthermore –taking also branch B of this VLD project into consideration- sharing of information will improve flight predictability (that produces benefits on ATM capacity), and sharing of flight intentions between ANSPs, with any or both aircraft, airline operations centres could improve the adherence of ATM to User preferences. Improving of routes has a direct effect on both CO_2 emissions and fuel consumption, i.e cost reduction. The VLD should involve an appropriate number of Oceanic Centres and Airspaces Users to substantiate the benefits of the above, and should optimize the shared data (as more shared data delivers more benefits to the ATM system).

Maturity

As mentioned above, this VLD builds on the working results coming from

1. SESAR FO-IOP validation exercises;
2. Eurocae ED-133 standardisation update; and
3. A6 FO-IOP industrialisation.

The VLD intends to support the deployment of FO-IOP, from this perspective the VLD will bridge the gap between the end of SESAR validation and beginning of operational service. It works on the solid ground of already achieved validation activities and available standards.

This VLD supports deployment by taking steps for development, integration and installation of Flight Object equipped ATM systems; this goes far beyond V3 scope.

The Operational Improvement AUO-0303-A ‘Ground-ground aspects related to iRBT/iRMT revision (executed at ground or flight crew initiative)’ will reach V3 Maturity level within R5.

Need for coordination at European/Global level

Branch A of this Flight Object Interoperability project involves ANSPs and Network Manager stakeholders. All FO-IOP activities so far have been coordinated within SESAR, within the A6 ANSP’s group and with EUROCONTROL. FO-IOP by its very nature is a topic that goes beyond the scope of a single ATM stakeholder and thus requires coordination at all lifecycle activities starting at requirements capture until entering into operational service. Branch B extends the scope of the project to non-European stakeholders and addresses, beside the ground/ground integration, also the A/G integration (ATM/AOC).

Complementarity with the Programme

Related Strategic Priority Business Needs (SPBN)

- ☐ Airport Integration and throughput
- ☐ Conflict Management and automation
- ☒ Moving from Airspace to 4D Trajectory Management
- ☐ Traffic Synchronisation
- ☒ CNS/SWIM
- ☐ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)	
This FO-IOP VLD contributes in parts to the following OFAs: • OFA03.01.01 - Trajectory Management Framework • OFA04.01.02 – Enhanced arrival & Departure Management in TMA and En Route • OFA03.01.08 - System Interoperability with air and ground data sharing	
Related Operational Improvement Steps (OIs)	
This FO-IOP VLD contributes in parts to the following Operational Improvements (OIs): • TS-0103 - Controlled Time of Arrival (CTA) through use of datalink • AUO-0302-A - Datalink exchange between Flight Crew and Controller for time based implementation related to airborne part of operation • AUO-0303-A - Ground-ground aspects related to iRBT/iRMT revision (executed at ground or flight crew initiative) • AUO-0205-A - Management and sharing of the Initial Reference Business Trajectory (iRBT/iRMT) from publication through to termination • IS-0302 – Use of Aircraft Derived Data (ADD) to enhance ATM ground system performance • IS-0303-A - Downlink of onboard 4D trajectory data to enhance ATM ground system performance: initial and time based implementation	
Related PCP ATM Functionality (if applicable)	
☐ AF1: Extended AMAN and PBN in high density TMAs	☐ AF4: Network Collaborative Management
☐ AF2: Airport Integration and Throughput	☒ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☐ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)

2.6 PJ28 – Integrated Airport Operations

PJ.28: Integrated Airport Operations
Demonstration Overview

Objective: Integration of Airport (AOP) and Network (NOP) data; surface traffic planning and management; and collaborative airport and network processes that deliver arrival and departure predictability for both the airport and the network in nominal and adverse conditions. Deploy an APOC with comprehensive AOP/NOP data connection and an initial dash board / decision support suite with basic "what-if" modelling capability.

1. **Planning:** deploy integrated airport collaborative planning processes, inclusive of surface routing planning activity. The goal is to optimise airport processes that likewise optimise airline operations on the ground. This should incorporate output of airport-DCB, winter operations (de-icing) management (included in planning), and abnormal/adverse conditions and event management (e.g. local weather, snow/ice). Demonstrate airport/network performance based decision-making in the planning timeframe including; MET forecasting support; airport DCB analysis; what-if modelling tool capability incorporating pre-defined CDM solutions; and collaborative decision-making processes.
2. **Airport Management Processes:** Deliver departure and arrival flow predictability and efficiency to the airport and the network through a milestone approach. The departure/arrival flow management should include the surface management elements of the trajectory i.e. departure/arrival flows should finish/start at the gate. Deploy integrated APOC and Network Manager collaborative management processes covering UDPP (Slot Swapping), airport-DCB, dDCB, and abnormal/adverse conditions and event management (e.g. local weather, snow/ice, diversions) as support tools to the Airport-Network coordination process. Demonstrate airport/network performance-based decision making in the execution phase of operations, including; MET now-casting support; 'what-if' modelling tool capability incorporating pre-defined CDM solutions; and rapid collaborative decision-making processes.
3. **Airport Safety Nets**: Deploy Airport Safety Net processes and technologies (both on the ground and in the cockpit) covering Surface route planning and guidance for aircraft and vehicles through the use of Manual Taxi capability and airfield lighting (where available) with associated safety nets for surface and runway controller (alerts to controllers for ATC conflicting clearances and Non-conformance to ATC instructions or procedures) and pilots. This should address nominal and abnormal/adverse conditions (e.g. local weather, snow/ice).
4. **Data Exchange including MET**: Exchange of data for the purposes of the integrated activities and collaborative process should be via SWIM where appropriate. SWIM platforms should be used for exchange between the Airport and the Network, however intra-airport data connections may be via existing technology.

Airport Types: The proposal should consider both major European airport (APOC/AOP) and regional (medium to small) airport (limited and affordable A-CDM (Advanced tower level) and AOP) solution deployments. Furthermore, the validation would benefit from assessing airports that deploy some of the APOC processes in a manual manner.

The airports proposed for separate exercises should reflect different types of operation (hub, regional, point to point), different traffic mix and types (hub carriers, low cost, charter operators, business aviation, helicopter operations), and different capacity constraining elements (gates/stands, manoeuvring area/taxiways, de-icing capability, runway configurations / usage restrictions, noise, TMA).

Exercises: The goal is the deployment and integration of planning and management tools along with supporting collaborative processes demonstrating the benefit of individual APOCs fully integrated in the operational network through a variety of operational conditions (nominal and adverse). The project shall consider, and where possible involve, the variety of aircraft equipage in order to validate the robustness and interoperability of airport safety nets.

The final exercise should focus on a live demonstration, over an extended time period (days/weeks) collaboratively managing airport performance goals and collaborative processes to show the benefit of the APOC and network linked through AOP/NOP connection.

Separate exercises can be proposed in order to address the different airport operational models. Management of the Network Manager workload should be explained if proposing multiple airport exercises at the same time.

Exercises demonstrating specific elements of the total concept are proposed with a final all-encompassing exercise demonstrating integration within the airport and integration of the airport into the Network.

Justification against prioritization criteria

Significant contribution to performance expected

Predictability brought by collaboratively planning and managing demand/capacity balance, planned activities, coherency of slots to flight plans, pre-departure flows with surface management executing the plan and deviation predicted and corrected, arrival synchronisation, resource planning and adverse condition processes leading to updated and aligned AOP/NOP.

Capacity/Resilience reduction related to adverse conditions is minimised (lessened) through;

- Planning and management of surface movement and winter (de-icing) operations based on shared met forecasts and now-casts.
- modelling of the latest demand (updated trajectory information S/RBT) over agreed timeframes and supported by collaborative decision making processes to permit proactive management and quicker recovery back to planned operational levels.
- Robustness against the variety in aircraft equipage.

Safety brought by common stakeholder awareness of the AOP as well as ATC use of planning and routing capabilities integrated with adverse condition processes (e.g. de-ice) and safety nets detecting and correcting surface and runway deviations and errors.

Environment brought by collaboratively managing the airport demand and capacity balance, inclusive of surface and runway flows linked to gate and turn round management. Pre-departure planning addressing nominal and adverse condition processes (e.g. de-ice) reduce to ground contamination (from anti-icing/de-icing chemicals) as well as reducing air and ground holding and the subsequent noise, CO2, NOx and particulates.

Efficiency brought by all airport stakeholders' collaboratively planning and managing surface and runway movements linked to gate and turn round management, pre-departure planning, arrival synchronisation and resource planning plus adverse condition processes (e.g. de-ice).

Flexibility brought through stakeholders participating in the collaborative processes with shared situation awareness and a common goal.

Maturity

AO-0205, Automated assistance to controller for Surface movement planning & routing - 2016; VLD activity; Provision of accurate taxi times to the AOP. Demonstration of alerts to controllers in the live environment

A0-0208 A; Advanced Information Management and System Integration in the ATC Tower for Step1 - 2015

AO-0209; Enhanced runway usage awareness to reduce hazardous situations on the runway – 2016, VLD activity; Demonstration of alerts to controllers in the live environment

AO-0801; Collaborative Airport Planning Interface – 2016, VLD activity; Demonstration in the live environment and linked with the NOP inclusive of collaborative processes.

AO-0803

Integration of Airports into ATM through Monitoring of Airport Transit View (extension of Performance Monitoring building on A-CDM)

2016, VLD activity; Demonstration in the live environment and linked with the NOP inclusive of collaborative processes.

AO-0804; Collaborative Airport Performance Management – 2016, VLD activity; Demonstration of the APOC in the live environment using collaborative processes to engage with Airport stakeholders including the Network Manager and Airspace Users.

AUO-0101-A; ATFM Slot Swapping for Step 1 – 2014, VLD activity; Integrated as one of the collaborative processes utilised in the planning and management activities of the APOC

AUO-0203-A; Shared Business / Mission Trajectory (SBT) in Step 1 – 2014, VLD activity; Used to build the AOP

AUO-0204-A; Agreed Reference Business / Mission Trajectory (RBT/RMT) in Step 1 – 2014, VLD activity; Used to update the AOP

AUO-0603-A; Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing in Step 1 – 2016, VLD activity; Demonstrated in the live environment (via Manual Taxi capability and airfield lighting)

AUO-0605-A; Airport Safety Net for Pilots in Step 1 – 2015, VLD activity; Demonstration in the live environment

CM-0103-A; Automated Support for Traffic Complexity Assessment – 2014, VLD activity; Used by the

Network Manager to support planning and execution decision making.
DCB-0103-A; Collaborative NOP for Step 1 – 2015, VLD activity; Used to enable AOP-NOP integration
DCB-0208; DCB in a trajectory management context – 2015, VLD activity; Used by the Network Manager to support planning and execution decision making.
DCB-0304; Airport CDM extended to Regional Airports – 2011, VLD activity; Deployed at the Regional Airport/s involved in the demonstration exercise/s
DCB-0308; Advanced Short Term ATFCM – 2015, VLD activity; Used by the Network Manager to support short term planning and execution decision making.
DCB-0309; Airport Demand-Capacity Balancing (A-DCB) – 2016, VLD activity; Runway DCB used as a support tool to the APOC in the planning and execution timeframes.
IS-0301; Provision and use of FOC/WOC data to enhance ATM ground system performance – 2012, VLD activity; Used to build AOP
IS-0901; SWIM for Step 1 – 2015, VLD activity; Used to enable AOP-NOP integration
MET-0101; Enhanced operational planning decisions through MET information integration – 2015, VLD activity; Demonstration inclusive of MET forecast and now-cast information to support planning and management of capacity and resource decision making.
TS-0103-A; Controlled Time of Arrival (CTA) – 2014
TS-0202; Pre-departure sequencing supporting by route planning – 2012, VLD activity; Used for TSAT generation
TS-0309; Sequence based integration of arrival and departure management – 2014, VLD activity; Required for the Surface planning i.e. updated information on the sequence of aircraft received or to be delivered by the Surface management system/processes.

Need for coordination at European/Global level

The following functionality and processes need to be integrated:

Function / Process	Systems	Involved Stakeholders	Coordination type
Full AOP-NOP data integration	AOP NOP AINS	Airport Network	G/G
Integrated arrival, surface and departure management, including associated ATC safety nets during the planning and execution timeframes	AMAN SMAN / A-SMGCS / Safety Nets DMAN DIMT	ANSP Airport EUROCAE AU? (Flight Crew)	G/G
DCB monitoring at both airport and network level.	RMAN AOP ASDI	Airport ANSP Network	G/G
Airport Transit View monitoring, from arrival to departure.	A-CDM APAMS	Airport AU / Ground Handler	G/G
MET alerts and adverse conditions assessment/management.	APAMS IWIS MET CWP WIS ADS	Airport / De-Icing Agent ANSP Network MET AU / Ground Handler	G/G
Network and Airport monitoring and impact assessment/management.	APAMS dDCB	Airport Network	G/G
Common agreed KPI and shared targets.	APAMS	Airport / De-Icing Agent ANSP Network MET AU / Ground Handler	G/G

A performance suite with what-if modelling capability and collaboratively pre-defined solutions.

Complementarity with the Programme	
Related Strategic Priority Business Needs (SPBN)	
☒ Airport Integration and throughput	☐ Traffic Synchronisation
☐ Conflict Management and automation	☒ CNS/SWIM
☐ Moving from Airspace to 4D Trajectory Management	☒ Network Collaborative Management and Dynamic/Capacity Balancing
Related Operational Focus Areas (OFAs)	
• OFA 01.02.01 – Airport Safety Nets • OFA 01.03.01 – Enhanced Runway Throughput • OFA 04.01.02 – Enhanced Arrival & Departure Management in TMA and En-route • OFA 04.02.01 – Integrated Surface Management • OFA 05.01.01 – Airport Operations Management • OFA 05.03.07 – Network Operations Management • OFA 05.03.06 – UDPP • OFA 05.03.04 – Enhanced ATFCM processes	
Related Operational Improvement Steps (OIs)	
Refer to Maturity Section above	
Related PCP ATM Functionality (if applicable)	
☐ AF1: Extended AMAN and PBN in high density TMAs	☒ AF4: Network Collaborative Management
☒ AF2: Airport Integration and Throughput	☒ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☒ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)

2.7 PJ29 – Remote Tower Control

PJ.29: Remote Tower Control
Demonstration Overview

- This project contributes to SDM-0205 (Remotely Provided Air Traffic Service for Multiple Aerodromes). The project will build on current OFA 06.03.01 activities that are expected to provide V3 maturity.
- This project shall demonstrate feasible, cost efficient and safe operations of multiple remote aerodrome control from a single site.
- The project will demonstrate the capability of a single Remote Tower Centre (RTC) to provide shared Air Traffic Services control for a number of airports simultaneously, through traffic coordination, when required by higher traffic demand. The airports will be low to medium traffic density airports, either constantly or at certain periods of time (e.g. seasonably, at specific days of the week, at night, etc.). The remote airports will be provided with the technical systems to support remote control.
- For the purposes of the demonstration, local ATC services will be maintained fully operational, either to provide hot backup to the RTC, or to allow shadow mode operations from the RTC during trials. Fully operational Remote Tower Modules (RTMs) will be provided within the RTC, with the technical capabilities for serving multiple airports (one-to-one, or one-to-many) to pursue the demonstration objectives. Reversion between single remote and multiple remote operations will be demonstrated.
- Different operational scenarios, addressing traffic complexity, weather conditions, low visibility conditions, VFR/IFR flight mix, etc. will be encompassed by the set of demonstration exercises.
- The demonstration will evaluate, *inter alia*:
  - The human performance issues when managing aerodrome control at several airports simultaneously. There should be different airport configurations with operations under different weather conditions for the ATCO to handle. The technical base will be the already approved RTC environment from OFA 06.03.01.
  - The value of enhanced situational awareness in all weather conditions by the use of technical support tools for enhanced vision.
  - The potential gains in cost efficiency.
  - The impact on other KPAs, in particular capacity, security, etc.
  - The replicability for different clustering of airports.
  - The deployment scenarios and selection criteria for investment decisions.
- The demonstration will document safety aspects and take responsibility for coordinating necessary agreements with EASA and National Supervisory Authorities. Furthermore the project will contribute to standardisation activities.
- The demonstration will cover the timeframe given with wave 1 (2016-2018).
- The demonstration will be set up by ANSPs and industry partners as the core stakeholders. The project will be based on expertise for Remote Tower developed within SESAR and/or local implementation programmes (which will both be finalised at the start of this proposed project).
- The demonstration will be in shadow mode, whilst operational control is maintained by local ATC. Therefore fully operational controller working positions (CWPs) will be provided for the multiple remote working positions where a full operational and technical scope can be demonstrated.

- The Reference case will be taken from already-performed RTC tests in 6.9.3.

Justification against prioritization criteria

Significant contribution to performance expected

- While the key performance indicator, being the driver for development of Multiple Remote Tower, is increased cost efficiency for small and medium sized airports, all validations and demonstrations will focus on confirming that the required level of safety can be provided.
- The safety level will have V3 maturity at the start of the proposed demonstration based on results from SESAR validations 6.9.3 EXE-VP-060, EXE-VP-061, EXE-VP-063 and 6.8.4 EXE-VP-641, EXE-VP-750, EXE-VP-752).
- The baseline with one airport for RTC has shown positive effects, and the next step will be several airports to gain more evidence and confidence on the proof of concept for remote ATS services provided at several airports. The challenging question will be how many airports can be served from one single RTC? This is of course depending on the traffic density and traffic distribution at each airport in the cluster. This is also a question of how the recourses are shared between the different groups, e.g. one ATC team, one RMT etc. Then when analysing the results of the VLD there can be evaluation points like will the runway throughput on the airport be suffering due to heavy workload? Also evaluated will be whether the technical equipment for a multiple RTC is mature.
- Another application of the concept is the control of several ground sectors at major airports from a single ground tower location. This situation is characterised by heavy traffic load and very dynamic traffic situations. An integrated controller working position with A-SMGCS Routing and Guidance functions will be prerequisites for this concept.
- The economic benefits shall be evaluated to understand the justification of RTC for multiple airports. If the RTC centre can be controlling several satellite airports the ATCO can control the flow into the main airport without communications. Better cost effectiveness can be reached through large scale operation with collocation of staff, management, training, etc.
- The demonstration will contribute to an improved confidence in applicability of the Multiple Remote Tower Concept in low to medium traffic airports. Further applications of the Remote Tower Concept, like Contingency Towers and Remote Ground / Apron Control, are relevant for larger airports and will also be ready for demonstration within the VLD timeframe.

Maturity

- The expected V3 target date for Multiple Remote Tower is 2015.
    - Project plan Q3 2014
    - OSED Q4 2014
    - Demonstration plan Q2 2015
    - Live trail (simulation) Q4 2015
    - Report Q2 2016

Need for coordination at European/Global level

- The results of the proposed demonstration will support implementation at European/Global level, providing input to standardisation needs. As the Multiple Remote Tower Concept will be demonstrated at a very challenging environment, i.e. airports with relatively high traffic volumes, applicability at smaller airports can be derived.
- As there is an emerging variety of industry providing modules required for Remote Tower

Operations, the project can support standardisation.

- The multiple TWR development is likely to push for new requirements in the G/G communication domain, system interoperability and SWIM.
- The concept of Multiple Remote Tower can be implemented at a European level. Nevertheless there are many different environments in the different countries that will have similar but still different implementations. There is a strong need to develop a common understanding of how many airports with a certain amount of traffic can be controlled by a single ATCO.

Complementarity with the Programme

Related Strategic Priority Business Needs (SPBN)

☒ Airport Integration and throughput

☐ Traffic Synchronisation

☐ Conflict Management and automation

☒ CNS/SWIM

☐ Moving from Airspace to 4D Trajectory Management

☐ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)

- OFA 06.03.01 (Remote Tower)
- OFA 01.02.01 (Airport Safety)
- OFA01.02.02 (Enhanced situational awareness)

Related Operational Improvement Steps (OIs)

Assumed V3 Target Dates of Each Solution and also the Assumed OIs

- AO-0204 2017-12-31
- AUO-0401 2018-12-31
- AO-0201-A 2014-12-31
- AO-0102 2017-12-31
- AO-0202 2015-12-31
- SDM-0201 2014 -12-31
- SDM-0204 2014-12-31
- SDM-0205 2015-03-15

Related PCP ATM Functionality (if applicable)

☐ AF1: Extended AMAN and PBN in high density TMAs

☐ AF4: Network Collaborative Management

☒ AF2: Airport Integration and Throughput

☐ AF5: iSWIM

☐ AF3: Flexible Airspace Management and Free Route

☐ AF6: Initial Trajectory Information Sharing

Wave

☒ Wave 1 (2016-2018)

☐ Wave 2 (2019-2021)

2.8 PJ30 – User-Preferred Operations

PJ.30: User-Preferred Operations
Demonstration Overview
The purpose of User Preferred Operations is to embed trajectory optimisation from AU's ground systems into a collaborative ATM environment during all flight phases, including the execution phase. Trajectory generation and prediction should consider besides the regulatory, safety and networks aspects also the business needs from airspace users. The goal is to share highly accurate AU trajectory through the architecture and processes to be defined within the programme's BMT and TMF OFA and 4D architecture study (and aligned globally only as far as required through ATMRPP's FF-ICE, leading to ICAO SARPs), and the information definitions of the FIXM Model and as described in the SESAR ConOps to enable airspace users to plan and fly as close as possible to their user-preferred 4D route. All involved ATM stakeholders, especially ANSP'-s (during execution phase) and the NM (for planning phase) should facilitate improved AU operation using FOC information support of high-resolution trajectory information. The primary focus lies, therefore, on enabling all actors to make better decisions, particularly in the execution phase, based on seamlessly shared 4D trajectory information accessible at any time from the Flight Operation Centres. In addition the sharing of common Airspace Data via SWIM among all is essential to ensure common views among all stakeholders. This VLD supports the operative validation of the negotiation process for the definition of the SBT and RBT principles through the option for any ATM stakeholder to trigger 4D flight trajectory calculations at FOC systems at any time to improve his operation and to define the best RBT from airspace user perspective. This VLD addresses an advanced integration of AU business needs to facilitate the implementation of 4D trajectories as a new operational framework. It will show easy and flexible access to all Flight Operator information in reference to 4D Trajectory calculation. It will showcase new options for the NM and ANSP's to utilize user preferred routings resulting from 4D trajectory calculations based on all essential airspace user input information. This will enable the NM to improve their network scenario calculations for planning and ANSPs to refine their trajectory predictions for the execution phase. Main objectives are: • Consideration of AU business needs expressed through the 4D trajectory calculated by the FOC ground systems • Improved fuel efficiency through options of increased usage of 4D trajectory intentions of airspace users • Increased situational awareness due to the availability of the current 4D trajectory to all stakeholders through all phases of flight. • Provision of high-resolution trajectory information by Airspace Users to communicate the AU's intention to other stakeholders in the best possible way during all phases of flight. • Supporting free route operations by creating 4D trajectories based on AU's preferred intentions and sharing the essential information of all routing details in reference to the 4 dimensions. • Improved accuracy of ATC complexity assessment through the utilization of AOC optimised trajectories throughout the ATC flow management processes and TP predictions. • Improved network-wide airspace usage prediction through using high accuracy information of the 4D trajectory primary within ground systems. The generation of what-if scenarios could also be used to further optimize airspace utilization. • Harmonised picture of all ATM information (AIS, ATC Planning, ATFCM data, etc.) and the ability to easily query any subset of data • In technical terms: through the application of SWIM standards and usage of compliant exchange formats (AIXM, WXXM, FIXM) , the harmonized picture of all ATM information is guaranteed, as necessary, in order to enable the consistent 4D trajectory calculation and exchange between all actors. • To demonstrating the technical feasibility of analysing AU intentions for 4D trajectory purposes automatically in real time at the controller working position using ATC as well as NM systems **Planned Demonstration approach** **What:** The FOC will allow any ATM stakeholder to trigger the re-calculation of the user-preferred 4D trajectory at any time. The basic principles of 4D trajectory information sharing is already validated through exercises between Network Manager and FOC. New options for requesting 4D trajectories are the consequent and beneficial development within this VLD.

FOC ground systems will provide 4D trajectory information for any flight handled by that AOC based on the FIXM domain data model in the context of the SBT & RBT definition process to all affected and interested stakeholders. The 4D trajectory calculation parameters will consider besides the important AU variables like aircraft mass, aircraft performance, fuel policies, company NOTAMs, route path optimisation criteria, internal business rules, cost index, etc. also the common view on airspace status and airport infrastructure status information.

All information shared through the 4D-trajectory data will be based on global standards for data models, services and processes. Therefore future global ICAO standards for flight information exchanges will be used, which, once appropriate services (and their data payloads) are defined, enables the participation of any ATM stakeholder outside of Europe in this VLD. A standard like FIXM allows the exchange of additional regional and local 4D information payloads, which are not in the FIXM core and where applicable local implementation of extensions will be used. This will demonstrate the system-to-system interoperability, e.g. of SESAR VLDs with other regional implementations such as NextGen and the experience and results of the VLD will in addition support further definition of the FIXM model.

How: FOC ground systems for flight planning will be extended to generate 4D trajectory information in FIXM format. These FOC ground systems will offer SESAR SWIM-compliant B2B services to trigger a 4D trajectory re-calculation for any scheduled flight by any ATM stakeholder during the planning and tactical phase. The NM and ANSP ground systems need to be updated with functions to make use of FOC-provided 4D-trajectory information. The VLD should preferably comprise at least 1000 real flights that utilize FIXM information sharing including triggering of re-calculations. Only such a sufficiently large dataset will allow a meaningful analysis of the influence of these changes on key performance indicators (KPIs), e.g. fuel efficiency and trajectory prediction accuracy. It is essential that ANSPs and the NM codify and share otherwise unknown regulations like profile tuning restrictions (PTR) or any local agreements among ATC authorities.
AOC ground systems will benefit from improvements in the supply of aeronautical information to cover the ATFCM, ATC and Airspace User's operational needs

Where: Through the developed B2B service calculations can be triggered from any authorized ground or airborne system (SWIM Yellow profile B2B to NM, and SWIM Blue profile (ED-133) for NM to ATC). Especially the main ground systems users from NM for planning or any ANSP for execution phase could take full advantage of the FOC calculation capabilities offered by appropriately extending their systems. This VLD will support in large part the centralized service for 4DPP. The concept of this VLD is based on the initial principles of the exercises for 4D trajectory information sharing between FOC & NM and also between FOC & ANSP under the framework of WP11.1.

Who: Airline Dispatchers, NMF, LTM, Planner and Executive Controllers of several FIRs, UIRs, NM, Pilots, all affected ANPs during flight execution. In case of FPL trigger from the cockpit, the data communication of ground B2B services must be refined.

The objective of the VLD is to demonstrate the readiness of affected and interested ATM stakeholders to facilitate user preferred flight intentions involving NM and ATC actors in an interoperable environment closing the gap between the planning intentions and real flight execution.
Demonstration 1: FOC system used by at least 10 airlines will provide B2B services for calculation of 4D trajectories shared through FIXM
Demonstration 2: ANPS systems will be enabled to trigger 4D trajectory re-calculations offered by the FOC system
Demonstration 3: NM systems will be enabled to trigger 4D trajectory re-calculations offered by the FOC system
Demonstration 4: 4D trajectory-planning systems will be enabled to trigger 4D trajectories offered from the FOC system
Demonstration 5: ANSP system will demonstrate refined TP prediction based on offered FOC options
Demonstration 6: NM system will demonstrate increased demand prediction based on offered FOC options and local traffic complexity management will be improved.
Demonstration 7: Incorporate of FAA systems and data will demonstrate global interoperability through FIXM flight information. So, FAA will be entitled to trigger 4D trajectory calculations as well to get a best possible picture from the airline intentions.
Demonstration 8: Airlines will monitor the fuel efficiency of approx. 1000 trial flights to analyse if the NM and ATC better accommodated user preferred routings.

Demonstration 9: Fully digital aeronautical data chain from survey to procedure design up to end user
Demonstration 10: Fully digital data for pilot awareness in VFR operations
Demonstration 11: Fully digital data for pilot awareness in-flight (IFR) and during ground movement

In reference to 9-11 it must be noted, that one of the most important lessons from the Extended Flight Planning validation is that the best trajectory processing systems can achieve very little if they are not supported by accurate, reliable and common ATM Information. For this reason a VLD dedicated to trajectory optimization has to include demonstrations on the technical and operational feasibility of the digital integration of the complete data chain

The focus of the technical verifications from each individual demonstration will be enhanced in the next version with operational aspects.

Justification against prioritization criteria

Significant contribution to performance expected

Performance Expected as assessed as part of V1-V3 results:

- The AU gets the option of flying optimized routes as the planning and execution of 4D trajectory intentions is shared any time. Affected and responsible stakeholders can even trigger visibility and traceability to the AU's 4D trajectory intentions.
- This is an essential enabler to fuel efficiency, capacity and safety
- Improved cost effectiveness through improved flight operation. Since at real time 4D trajectory intentions information is provided from the airlines, this information can be used for network planning and trajectory management to reduce flight times and less fuel consumption.
- Reduction of fuel consumption based on improved vertical profiles facilitated from NM and ANSP

V2 exercise 616 provided initial indications about improved values for capacity. Furthermore, VP713 with V3 maturity will include aspects from airspace user's perspective. Furthermore the planned validation VP 775 which is aiming to be V3 validated at Release 6 is the basis for collaborative Trajectory Management between AOC & ATC. The VLD significantly contributes to increased confidence in the expected benefits on operational level and to successfully interconnect ATM systems in a more efficient way as today

As the concept of VLD is aiming to support especially NM and ATC to evaluate, how 4D trajectory intentions from AU are available and expressed, consequently these ATM stakeholders will get familiar to consider AU's needs and facilitate as best as possible the user preferred operation.

Maturity

V3 status for relevant OI steps are expected by Releases 5 & 6
VP713 will demonstrate enhanced 4D Trajectory information share by use of the EFPL in Release 5
The validations exercises in reference to RBT/SBT are planned within VP775 and expected to be V3 compliant at Release 6.

EXE616 made clear, that is essential to demonstrate any new concepts as best as possible close to an operational environment. The validation of key benefits is strongly dependent on real operational information share and usage. The detection of operational findings is solely possible in operational environments.

Real flight events in large number will give all affected stakeholder the options to get experience how new information could be used and how AU intentions could be considered through new ATC functions for requesting AU's needs. This will support the confidence in providing additional services with higher quality aiming to facilitate as best as possible the preferred AU 4D operations.

Need for coordination at European/Global level

The application and availability of FIXM expressing the airspace users intentions ensure implicitly a global usage of 4D Trajectory information including business needs and intentions of AU's. The coordination with FAA is ensured within SESAR through the technical and OPS group of SESAR experts. The beneficial secondary effect within FIXM as central enabler of global interoperability is, that local or regional characteristics can be considered by using the extension options from the FIXM model. Depending to local needs of cooperating stakeholders, AU will provide all local characteristics through FIXM extensions.

Any affected and participating stakeholder is enabled to request during planning and execution phase

latest airspace user's intentions expressed through the 4D trajectory. Interoperability between G/G and A/G is managed through standardized B2B services. Transversal OFA cooperation is reached as the described concept is technically supporting free route operation and the BMT OFA.
Complementarity with the Programme
Related Strategic Priority Business Needs (SPBN)
☐ Airport Integration and throughput ☐ Conflict Management and automation ☒ Moving from Airspace to 4D Trajectory Management ☐ Traffic Synchronisation ☐ CNS/SWIM ☐ Network Collaborative Management and Dynamic/Capacity Balancing
Related Operational Focus Areas (OFAs)
• ENB02.01.01 SWIM • OFA03.01.04 Business and Mission Trajectory • OFA05.03.07 Network Operations Planning • OFA03.01.03 Free Routing
Related Operational Improvement Steps (OIs)
• IS-0301 - Provision and use of FOC/WOC data to enhance ATM ground system performance. • AUO-0203-A - Shared Business / Mission Trajectory (SBT) in Step 1 • AUO-0203-B - Shared Business / Mission Trajectory (SBT) in Step 2 • AUO-0204-B - Agreed Reference Business / Mission Trajectory (RBT/ RMT) in Step 2
Related PCP ATM Functionality (if applicable)
☐ AF1: Extended AMAN and PBN in high density TMAs ☐ AF2: Airport Integration and Throughput ☐ AF3: Flexible Airspace Management and Free Route ☐ AF4: Network Collaborative Management ☒ AF5: iSWIM ☒ AF6: Initial Trajectory Information Sharing
Wave
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2.9 PJ31 – Initial Trajectory Sharing

PJ.31: Initial Trajectory Sharing
Demonstration Overview
This project will set up the combination and synchronization of key Air and Ground functionalities in order to demonstrate a global improvement of ATC tools (CD&R [i.e. Conflict Detection and Resolution], conformance monitoring and Arrival Management) for enhanced operations, including improvement of flight efficiency and safety, and airport & airspace capacity. All of these ATC tools and related enhanced operations are at the heart of Ground-Based Separation Management and Arrival Management studied in SESAR. The demonstration will involve enhanced ATC tools (conformance monitoring, conflict detection, conflict resolution, Arrival Management) based on an enhanced ground Trajectory Predictor, fed with much more accurate A/C 4D trajectory information. 1) **[What]**: Key functional aspects of Traffic Control such as Conformance monitoring, Conflict Detection, Conflicts Resolution, Enhanced Arrival Management 2) **[How]** : Combination of key enablers such as : - Extended FPLN (from FOC - Flight Operational Center) and, more generally, A/C Flight Object - EPP (Extended Projected Profile, i.e. A/C downlinked predicted 4D trajectory) - Adequate wind & temperature data for accurate airborne computations of EPP - new/enhanced Ground Trajectory Predictor - new CD&R and conformance monitoring tools ; - Advanced Arrival Management with an Extended horizon fed with accurate 4D Trajectory data - supporting ground functions for circulation and exchange of the various Flight Object components with the adequate interoperability (synergies with DoW 1-6) 3) **[Where]** - Flight Operations Centres (FOC) of one or more airlines to provide Extended Flight Plan 4D data, as part of the AUs Flight Operational data - Same airlines and their partially equipped A/C to down-link the EPP (likely need for several tenths of equipped A/C) - NMOC and other TBD ground actors to transmit the global Flight Object data - Planner and Executive Controllers of several FIR, UIR and TMAs in ECAC area with different complexities and densities of traffic - Regarding A/C (or AUs), it is needed to select the ones that will cross the eligible areas in sufficient “quantity” so as to find a sufficient number of equipped A/C at a given time in a given area - it is wise to involve several, bordering areas from different ANSPs, to demonstrate Ground–Ground interoperability and efficient coordination based on the enhanced 4D Trajectory information. This is of the utmost importance regarding Enhanced Arrival Management operations, for which involved TMA[s] and ACC[s] need to be bordering. 3) **[When]** : The dates and times of the day cannot be identified in an absolute way ; they need to be carefully defined with the cooperation of the Airspace Users so as to reach the adequate “density” of equipped A/C at a given time in a given area As stated above, several tenths, perhaps nearly one hundred of A/C will probably need to be equipped in order to generate the situations able to demonstrate the efficiency of enhanced ground tools. The objective also is to obtain an important variety of combinations regarding A/C equipage (EPP or not) in a given area.

It is highly recommended to involve distinct ACCs (UIRs, FIRs), if possible from different ANSPs, and at least two TMAs. A first set of possible demonstrations is listed here below, numbered from 0 to 4, and might take place within either ECAC En-route areas or TMAs, involving both types of A/C, either EPP-equipped[4] or not. The "density" of EPP A/C in a given area shall be enough so as to ensure a sufficient number of crossings between two equipped A/C in order to gather technical and operational feed-back with sufficient relevance from a statistical point of view. Initial figures could be investigated by the relevant Primary Projects of WPs 4 and 5.
Demonstration # 0 has to be seen as "optional" since it is meant for recording and post-processing and does not directly impact the operations. Its usefulness in the path towards other demonstrations is to be assessed later.
Demonstrations # 1 to # 4 involve A/C downlinking their predicted 4D trajectory (EPP) in order to enhance the ATC tools and therefore improve the related operations.
In all cases, an Enhanced Trajectory Predictor (TP) able to make optimum use of the new and accurate A/C trajectory (E-FPLN; EPP) completed as necessary with legacy information (radar …) is at the heart of the targeted enhancements. This TP shall adapt to the A/C equipage as it will need to be the case during deployment.
Demonstration # 0 (Optional) Trajectory Predictor built with E-FPLN and/or EPP (in addition to legacy Primary or Secondary radar data) for recording of the resulting Ground Predicted Trajectory ➔ the objectives is to enable further comparisons with Enhanced Ground Trajectory Predictor without EPP augmentation to demonstrate the improved accuracy needed for the below demonstrations.
Demonstration # 1 Based on the TP developed as per # 0, it consists in its operational utilization to feed enhanced Conformance Monitoring tools ➔ Demonstration of the efficient usage by Controllers from a safety point of view.
Demonstration # 2 Same as # 1 with also the operational utilization of the Ground Predicted Trajectories to feed enhanced Conflict Detection tools applying adapted buffers for enhanced vertical and lateral separation ➔ Demonstration of the efficient usage by the Controllers as regards accurate detection of potential conflicts to illustrate the ATM benefits regarding Safety and Airspace Capacity (enabled by reduced buffers)
The nature of the buffers would depend on the fact that the handled A/C are EPP-equipped or not.
Demonstration # 3 Same as # 2 with also the operational utilization by enhanced Conflict Resolution tools applying adapted algorithms that compare and propose the best solution among lateral, vertical or speed instructions ➔ Demonstration of the usage by the Controllers regarding efficient resolution of detected conflicts and ability to increase Fuel Efficiency and Predictability.
Demonstration # 4 Utilization of either EPP directly or EPP-enhanced ground Trajectory Predictor (fed with EPP) for an enhanced Arrival management extended to en route phase, able to build optimum (robust, stable and efficient) A/C sequences to feed target runways ➔ Demonstration of more efficient A/C sequence building able to reduce the ATC workload, and able to increase TMA and airport capacity, as well as increasing the Fuel Efficiency and Predictability. The Threshold percentage of flights in a sector that would be needed in order to demonstrate benefits could be investigated by the relevant WP 5 Primary Projects..

Justification against prioritization criteria

Significant contribution to performance expected

[From B4.1 Perf Validation Targets (D39) and B5 OFA assessments (D68)]

- Ground Based Separation provision OFAs (both in En Route and in TMA) expected :
  - to increase by **2.46 %** (resp. by **3.41 %)** the airspace capacity (resp. the TMA capacity)
  - to reduce by **1.05 %** the flights variability

[4] Especially equipped for such a purpose in the context of this VLD

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- to reduce by **0.34 % to 0.81 %** the ANSP costs (at ECAC level)
- to reduce the unsafety by **0.61 %** (at ECAC level)

- Enhanced Arrival Management is expected :
  - to reduce by **0.12 to 0.25 %** the fuel consumption (at ECAC level)
  - to increase by **3.74 to 5.26 %** the airspace capacity (at local level)
  - to increase by **1.3 %** the Airport capacity (at local level, i.e. constrained airports)
  - to reduce by **0.75 to 2.81 %** the flights variability (at ECAC level)
- The live demonstration of new CD&R tools (based on both adapted separation buffers and adapted resolution algorithms) will permit to extrapolate the demonstrated ATM benefits to the whole ECAC area. However, demonstration of reduced CD&R buffers need a sufficient A/C equipage rate so as to provide a significant number of situations involving two EPP-equipped aircraft. Geographic and temporal definitions of the demonstrations will need to be defined to respect such need. Post-processing of trajectory data, in particular during the crossing of two EPP aircraft and/or following a conflict with at least one EPP A/C, will enable to extrapolate the CD&R efficiency to a future environment with much higher equipage rates.

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Maturity

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V3 status for the various OI steps belonging to Ground Based Separation are expected by Releases # 5 & 6

Every demonstration described in this DoW is to be carried out in realistic environments, similar to future operations. This is the only principle that can contribute to a significant de-risking of future deployment. In such a spirit it is expected that, as well as having reached V3, further work has been carried out so that:

- Airborne functions and systems are fully developed, based on mature standards and certified on the basis of regulations similar or close to the ones that will support deployment
- Ground functions and systems are fully developed based on mature standards and approved on the basis of regulations similar or close to those needed for deployment
- Air/Ground procedures are fully representative of the targeted mode of operations (possible mitigations may need to be considered)

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Need for coordination at European/Global level

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- By nature, the proposed demonstrations of future basic ATC tools are meant to illustrate what might be deployed in <u>every</u> ACC (FIR, UIR) or TMA in the whole ECAC area, albeit possible adaptation of CD&R tools
- It is expected / necessary that draft EASA Rules and adapted[5] Acceptable Means of Compliance, as well as mature standards for A/G and G/G interoperability, are available as input both for VLDs preparation/execution and for the needed industrial developments, in the spirit of the SESAR 16.1.4 Proof-of-concept. The contribution of EASA is to be accurately identified and anticipated, so that resources can be adequately planned.
- Partner ANSPs should submit to ICAO impacts on documentation (PANS OPS, SARPS, manual …)
- By nature, the proposed demonstrations will also illustrate the overall 4D Trajectory sharing between A/C, ATC, NM, FOC … The interoperability will be illustrated with the involvement of ANSPs from various sectors, countries, (possibly distinct FABs), as exchange of all 4D Trajectories and Flight Objects would be normalized beforehand (in particular : ED-133, FIX-M for the ground-ground interoperability). The exact frame is to be defined by the DOW 1.6 “Flight Object Interoperability”.

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[5] Adapted for the VLDs

Dissemination of demonstration results to other regions, particularly in terms of benefits, will be key to ensure global interoperability and the timely adoption of the standards at ICAO level (that in Aviation System Block Upgrade 1 includes "Improved Traffic Synchronization and Initial Trajectory Sharing"), and to reduce a possible risk of disconnection between EU and other regions such as FAA.	
Complementarity with the Programme	
Related Strategic Priority Business Needs (SPBN)	
☐ Airport Integration and throughput	☒ Traffic Synchronisation
☒ Conflict Management and automation	☐ CNS/SWIM
☒ Moving from Airspace to 4D Trajectory Management	☐ Network Collaborative Management and Dynamic/Capacity Balancing
Related Operational Focus Areas (OFAs)	
On the basis of Data Set 11 : OFA04.01.02 Enhanced Arrival & Departure Management in TMA and En-route (V3 TBD) OFA03.03.01 Ground Based Separation Provision in En Route (V3 R6) OFA03.03.02 Ground Based Separation Provision in the TMA (V3 R6)	
Related Operational Improvement Steps (OIs)	
On the basis of Data Set 11 : • TS-0305-A Arrival Management Extended to En Route Airspace - Single TMA • CM-0201-A Automated assistance to Controller for seamless coordination, transfer and dialogue through improved trajectory data sharing • CM-0205 Conflict Detection and Resolution in En Route using trajectory data in Predefined and User Preferred Routes environments • CM-0206 Conflict Detection and Resolution in the TMA using trajectory data • CM-0207-A Automated flight conformance monitoring in En-route in step 1 • CM-0208-A Automated flight conformance monitoring in TMA in step 1 • CM-0301 Sector team operations adapted to new responsibilities in En-route, 1 Planning to 2 Tactical controllers team structure • CM-0303 Sector team operations adapted to new responsibilities for Tactical and Planning controller in En-route	
Related PCP ATM Functionality (if applicable)	
☒ AF1: Extended AMAN and PBN in high density TMAs	☐ AF4: Network Collaborative Management
☐ AF2: Airport Integration and Throughput	☒ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☒ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021) (if useful)

2.10 PJ32 – Time-Based Separation

PJ.32: Time-Based Separation

Demonstration Overview

The lack of dynamic Wake Vortex separation has a negative effect on the runway throughput.

The current static ICAO Wake Vortex separation minima are too conservative and not optimised to the current fleet-mix. Radar separation on final approach is under some conditions the most constraining factor and can probably be reduced under certain conditions. In detail, current radar distance separation on final approach is expressed as a distance (Distance Based Separation, DBS) regardless of the prevailing weather conditions. It means that the same distance being flown in calm winds, as in headwinds, will take longer time to fly in the headwind conditions resulting in a reduction of landing rate as well as of runway throughput. This is particularly true in case of strong headwind conditions. To limit the impact on the landing rate, the concept is evolving towards a time-based separation (TBS) which leads to the stabilization of the time spacing between aircraft on final approach in headwind conditions.

In future work, new pairwise wake-vortex separation standards may be in existence and more advanced weather-dependent surveillance techniques will also be available. This VLD will provide additional analysis and experience to support this evolution.

This VLD addresses the demonstration of TBS in headwind conditions at airports other than London Heathrow, where the capability is already being implemented.

The VLD will demonstrate the following elements:

The application of TBS at capacity-limited airports in headwind conditions.

The ability of TBS to support a reduction in wake-vortex spacing between aircraft pairs where current wake vortex spacing minima are above radar separation minima

The demonstration will build on the exercises conducted during SESAR 1 at London Heathrow, which demonstrated that runway throughput can be increased under strong headwind conditions when separation minima based on time, rather than distance, are applied.

Justification against prioritization criteria

Significant contribution to performance expected

Benefits will be delivered through:

- Increasing the runway throughput in strong headwind conditions, thereby maintaining capacity.
- Improving predictability through increased confidence in the ability to maintain capacity in strong headwind conditions.

The V1-V3 exercises performed as part of OFA01.03.01 (VP-302 and VP-303) showed the following key results:

- Tactical airport capacity benefit (preventing loss of 1-5 movements per hour in challenging wind conditions) – No impact on declared RWY capacity.
- 108kg on average per flight across the simulated RTS wind conditions (43kg per flight if calculated across the annual wind conditions)
- Mean reduction of holding time was 0.9min with max. of 9.4 min
- Standard deviation for airborne holding reduced from 208 seconds (DBS) to 168 seconds (TBS).

The previous exercises were conducted at London Heathrow and were tailored for that airport's specific needs. The VLD will demonstrate value at additional airports, thus providing confidence that the concept is of more widespread value across Europe.

Maturity

VP303 – March 2012.

VP302 – July 2012.

Further related V3 exercises are planned in the 2015-16 period, and these will support additional TBS VLDs proposed for Wave 2.

The VLD will address multiple international airports ensuring that the successful validation at London Heathrow is applicable across a wider scope of airports.

Need for coordination at European/Global level

As TBS concepts evolve, to gain maximum benefit, regulatory activity will be necessary to support a reduction in spacing and separation on final approach. EASA's position on implementation of both RECAT-2 and reduced separation on finals is that it is still the responsibility of NSAs to decide and regulate. However, with additional proof of widespread applicability, the move towards Europe-wide regulatory activity will be justified and supported by evidence. This VLD, and that in Wave 2, will considerably assist in this process.

This VLD needs to be supported by controller-support tools, but there is no A-G or G-G interoperability. However, the Wave 2 VLDs, which build on this necessary first step, will introduce a requirement for A-G and G-G data exchange.

Complementarity with the Programme

Related Strategic Priority Business Needs (SPBN)

- ☒ Airport Integration and throughput
- ☐ Traffic Synchronisation
- ☐ Conflict Management and automation
- ☐ CNS/SWIM
- ☐ Moving from Airspace to 4D Trajectory Management
- ☐ Network Collaborative Management and Dynamic/Capacity Balancing

Related Operational Focus Areas (OFAs)

OFA01.03.01 Enhanced Runway Throughput

OFA04.02.01 Integrated Surface Management

OFA04.01.01 Integrated Arrival/Departure Management at Airports

Related Operational Improvement Steps (OIs)

The four essential OIs that will be ready by the end of the SESAR programme are:

- AO-0303
- AO-0306
- AO-0309
- AO-0310

Related PCP ATM Functionality (if applicable)

- ☐ AF1: Extended AMAN and PBN in high density TMAs
- ☐ AF4: Network Collaborative Management

☒ AF2: Airport Integration and Throughput	☐ AF5: iSWIM
☐ AF3: Flexible Airspace Management and Free Route	☐ AF6: Initial Trajectory Information Sharing
Wave	
☒ Wave 1 (2016-2018)	☐ Wave 2 (2019-2021)