01 July 2015

SESAR 2020
Multi-annual Work Programme

Edition 1.0

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1. Introduction & Context

This document corresponds to the "global work programme of the Joint Undertaking" as per Articles 7(5)(d) and 16 of the SJU statutes annexed to SJU Founding Regulation No 219/2007.

As such this document:

- ✓ is based on the financial framework referred to in Article 4(2) of this Regulation,
- ✓ is divided into periods of thirty-six months,
- ✓ sets out clear deliverables and milestones, and
- ✓ includes an estimate on programme costs.

Consequently this multi-annual work programme for the SJU covers the period 2016-2019 and has a further outlook to 2021; this latter period is in less detail as it largely depends upon the results from the first period.

The document has been developed on the basis of certain assumptions regarding the staff and financial resources that will be available to SJU in 2016-2021 based on data available as of June 2015. The document contains the context, objectives, budget and high-level description of the SESAR 2020 Research and Innovation (R&I) Programme and will be supplemented by an SJU annual work programme that will further detail and/or update this document as necessary.

This document will be regularly updated and submitted by the SJU Executive Director to the Administrative Board through production of a complementary annual work programme.

The SESAR Joint Undertaking (SJU) is responsible for managing R&I within the extended/renewed Partnership (SJU PPP) as well as open calls for participation under Horizon 2020 Indirect Actions. 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.

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'.

1.1 Research Phases

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

In addition, and spanning these phases, there is a need for transversal activities working 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.

1.1.1 Phase 1 – Exploratory Research

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.

1.1.2 Phase 2 – Industrial Research & Validation

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 SJU Partnership (PPP).

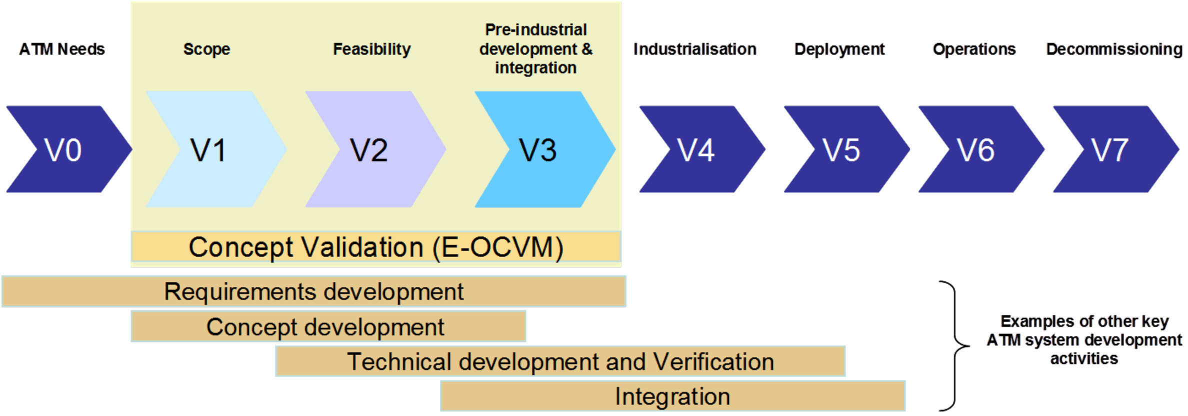
1.1.3 Phase 3 – Very large Scale Demonstrations

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). These will be delivered by a combination of work by the PPP Members and supplemented by open calls to broaden the participation and ensure key stakeholder participation.

1.2 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 E-OCVM will continue to be applied in the Programme 2020 in terms of establishing the flow of ideas and results; 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):

Exploratory Research (V0 & V1) covers:

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.

Industrial Research & Validation (V2 & V3) covers:

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.

Very Large Scale Demonstration (V3+) covers:

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

Industrialisation (Beyond SJU) covers:

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.

Deployment (Beyond SJU) covers:

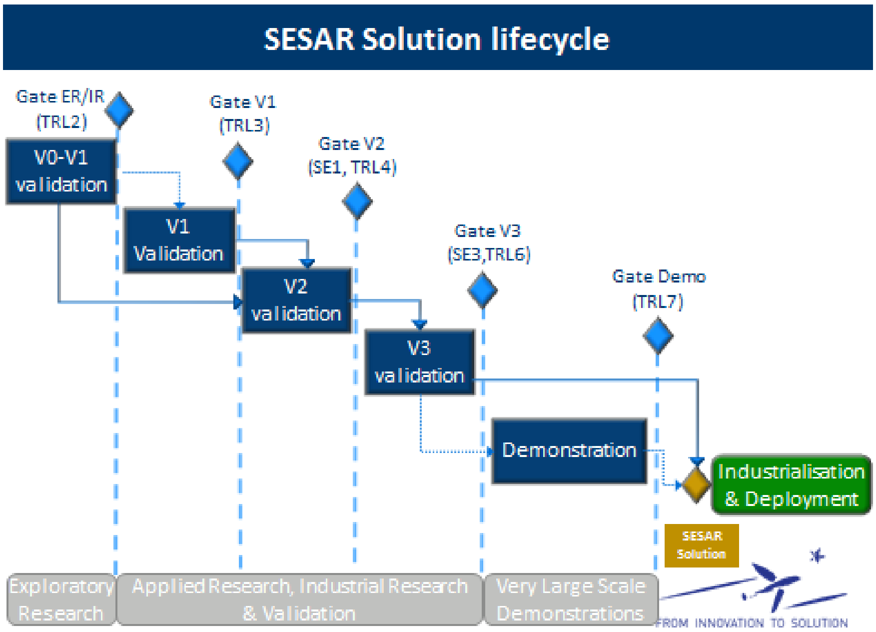
TRL 9 Actual system "mission proven" through successful mission operations (ground or space): Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed and successful operational experience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

Some extended V1 research activities may be required and will need to involve the Industrial members, including preparation for transition of results. To allow for this a limited range of V1 activities may be performed as part of Industrial Research. The gate overview is shown in the simplified diagram below.



1.3 Introducing the SESAR2020 Programme

The research challenges for Programme 2020 build upon the work undertaken in the ongoing SJU Work Programme (SESAR 1) 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.

1.3.1 Research Challenges & Key Features

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.

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

- Enabling the delivery of safe, cost-efficient and environmentally responsible Air Vehicle & ATM operations, systems and services

High Performing Airport Operations

Capacity, Safety, Environment, Efficient, Effective, Networked

Optimised ATM Network Services

Collaboration, Balancing Demand & Capacity, Environment, Efficiency

Advanced Air Traffic Services

Synchronisation, Capacity, Safety, Environment, Cost

Enabling the Aviation Infrastructure

- Providing shared technical services across the aviation domain
- Communications, positioning, navigation, timing and SWIM information
- Air vehicle operations, systems & services

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.

1.3.2 Exploratory Research (Science to TRL2)

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.

The SESAR Exploratory Research programme is constructed to 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 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.

The detailed content of the Exploratory Research programme will be described in call documentation, while an overview is maintained here to ensure account is taken of the relationship to the rest of the SESAR 2020 Programme and the flow of results.

1.3.3 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 of Operations
- The SESAR reference Architecture and Technical System Strategy
- SESAR Programme Lifecycle

The goal of the SESAR "Concept of Operations" 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 of Operations it foresees three so called "to-be" architectures that represent the target evolution of the European ATM system over time. Following the SESAR Reference Architecture, 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 the Clean Sky JU and its Partners.

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.

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

Very Large Scale Demonstrations are designed to help fill the gap between the 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.

1.4 Governance & Decision-Making in SESAR2020

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.

1.4.1 Executive Level Governance

This section describes the proposed governance arrangements and will be verified with the amended Administrative Board once this is in place for SESAR 2020.

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.

1.4.2 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.

At this stage in the development of the programme the governance arrangements are to be considered as <u>provisional</u>. 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.

<u>Scientific Committee</u>

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.

<u>Programme Committee</u>

It covers the Industrial Research & Validation and the Very Large Scale Demonstration phases of the Programme within the scope of the action plan and the more detailed action descriptions and is strategic in nature; a Programme Committee is set up within the context of the PPP 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 PPP Agreement). 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.

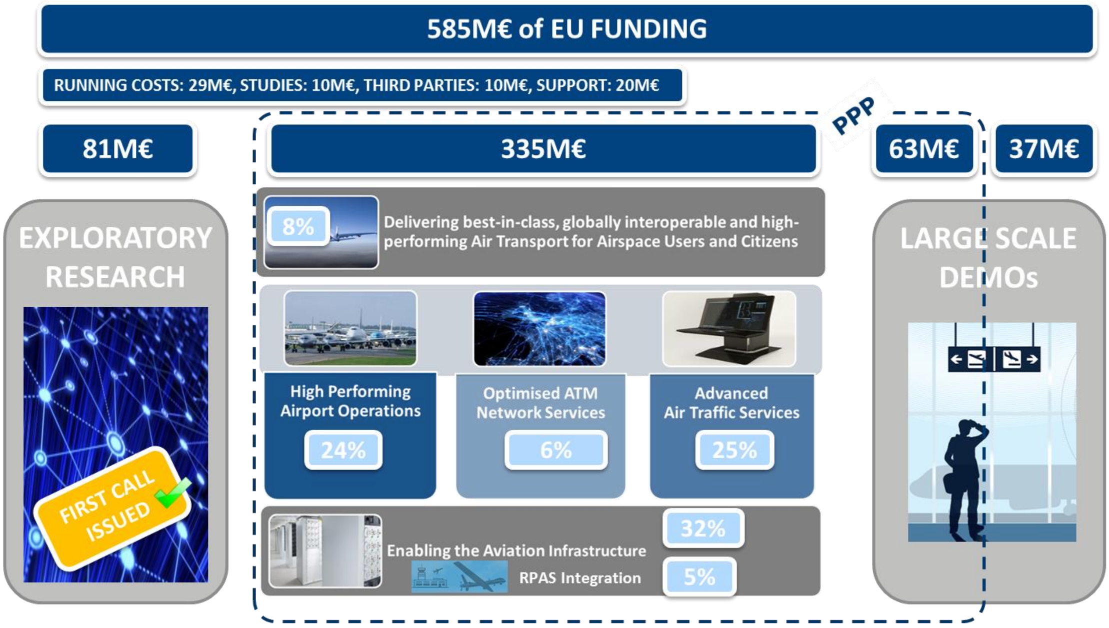
While during the previous years the Master Plan review exercise was performed on an ad hoc basis, considering the start of the deployment phase as well as the entrance of new key player(s) entrusted with the management of the SESAR Deployment, it appears necessary to avail the SJU and his Executive Director 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.

1.5 Organising & Funding the SESAR2020 Programme

In accordance with the regulation extending the SESAR JU and implementing financing over the perspective 2014-2020 an overall funding of 585M€, with 85M€ of this reserved for Exploratory Research, is available from H2020 research funds. In order to deliver the research and realise the 'pipeline to innovation' this funding is in principle distributed in accordance with the figure below:



- **2 waves 2016-19 & 2019-21 synchronised with the European ATM Master Plan cycle – 65%/35% split**

Each phase of research has its own needs and characteristics but organised and coordinated in a way that enables the transfer of results across the phases targeting performance results for the key features of the SESAR programme.

1.5.1 Exploratory Research

This phase of research is wholly funded from EU funds and done in full compliance with H2020 and "the rules of participation". Once SJU running costs (maximum 5%) are taken into account the preliminary estimate of funding available for research allocated across multiple calls will be up to 81M€.

Call 1 has been launched in 2015 for up to a total funding of up to 20.6M€. Further calls are expected in the periods 2016/17, 2018/2019 and 2020.

1.5.2 Industrial Research and Very Large-scale Demonstrations (PPP)

The PPP is co-financed by contributions from both the Industry Members and Eurocontrol through in-kind contributions and in accordance with the H2020 regulation and the financial rules. The total EU funding for the PPP is proposed to be 398M€, divided across Industrial Research & Validation and Very large Scale Demonstrations.

In operating the PPP it is extremely important for the success of the PPP in meeting its mission to have an appropriate allocation of funding across the key features (allocated per project) and the complementary allocation per major stakeholder type, specifically Airborne Systems, Ground ATM Systems and Service Provision. While not mandatory this distribution provides the basis for future calls for proposals and is fully described in the table below:

WORK AREAS	KEY FEATURE	TOPIC	NAME OF PROJECT	INDICATIVE BREAKDOWN PER R&I MATURITY PHASE (in % of TOTAL)			INDICATIVE BREAKDOWN PER SKILLS & COMPETENCIES			MAXIMUM CO-FINANCING VALUE
				V1 PHASE	V2 PHASE	V3 PHASE	AIRBORNE SYSTEMS CONTRIBUTION	GROUND ATM SYSTEMS CONTRIBUTION	SERVICE PROVISION CONTRIBUTION	
Transversa		1	PJ.19 Content Integration				2.100.000 €	3.000.000 €	7.700.000 €	12.800.000 €
		2	PJ.20 Master plan maintenance				1.400.000 €	1.600.000 €	2.400.000 €	5.400.000 €
		3	PJ.22 Validation and Demonstration Engineering				700.000 €	1.500.000 €	5.400.000 €	7.600.000 €
	TOTAL TRANSVERSAL WAVE 1 & 2						4.200.000 €	6.100.000 €	15.500.000 €	25.800.000 €
Industrial Research & Validation	High Performing Airport Operations	4	PJ.02 Increased Runway and Airport Throughput	13%	26%	61%	5.500.000 €	8.000.000 €	7.800.000 €	21.300.000 €
		5	PJ.03a Integrated Surface Management	15%	34%	51%	7.700.000 €	8.100.000 €	3.000.000 €	18.800.000 €
		6	PJ.03b Airport Safety Nets	8%	20%	72%	4.100.000 €	3.700.000 €	4.700.000 €	12.500.000 €
		7	PJ.04 Total Airport Management	13%	33%	53%	0 €	9.000.000 €	7.100.000 €	16.100.000 €
		8	PJ.05 Remote Tower for Multiple Airports	0%	17%	83%	0 €	5.600.000 €	4.600.000 €	10.200.000 €
	Optimized ATM Network Services	9	PJ.07 Optimised Airspace Users Operations	6%	40%	54%	2.500.000 €	1.200.000 €	1.900.000 €	5.600.000 €
		10	PJ.08 Advanced Airspace Management	5%	27%	68%	0 €	1.600.000 €	2.600.000 €	4.200.000 €
		11	PJ.09 Advanced DCB	10%	30%	60%	0 €	4.300.000 €	6.500.000 €	10.800.000 €
	Advanced Air Traffic Services	12	PJ.01 Enhanced arrivals and departures	4%	26%	70%	9.100.000 €	8.600.000 €	9.500.000 €	27.200.000 €
		13	PJ.06 Trajectory Based Free Routing	4%	13%	83%	800.000 €	3.400.000 €	5.100.000 €	9.300.000 €
		14	PJ.10 Separation Management En-Route and TMA	12%	30%	58%	1.400.000 €	20.700.000 €	17.800.000 €	39.900.000 €
		15	PJ.11 Enhanced Air and Ground Safety Nets	9%	22%	68%	3.100.000 €	3.600.000 €	1.400.000 €	8.100.000 €
	Enabling Aviation Infrastructure	16	PJ.13 Air Vehicle Systems	15%	32%	53%	6.800.000 €	4.900.000 €	3.900.000 €	15.600.000 €
		17	PJ.14 CNS	13%	29%	58%	11.800.000 €	19.500.000 €	3.900.000 €	35.200.000 €
		18	PJ.15 Common Services	18%	30%	52%	0 €	5.800.000 €	4.100.000 €	9.900.000 €
		19	PJ.16 CWP - HMI	20%	30%	50%	0 €	11.100.000 €	6.800.000 €	17.900.000 €
		20	PJ.17 SWIM Infrastructures	17%	33%	50%	1.700.000 €	11.000.000 €	1.900.000 €	14.600.000 €
		21	PJ.18 4D Trajectory Management	5%	24%	71%	10.000.000 €	11.800.000 €	10.700.000 €	32.500.000 €
	TOTAL SESAR 2020 PROJECTS WAVE 1 & 2			11%	28%	61%	64.500.000 €	141.900.000 €	103.300.000 €	309.700.000 €
TOTAL TRANSVERSAL & PROJECTS WAVE 1 & 2							68.700.000 €	148.000.000 €	118.800.000 €	335.500.000 €
Very Large Scale Demonstrations	High Performing Airport Operations	22	PJ.28 Integrated Airport Operations (incl. TBS)							4.300.000 €
	Optimized ATM Network Services	23	PJ.24 Network Collaborative Management							3.600.000 €
	Advanced Air Traffic Services	24	PJ.23 Flexible Airspace Management and Free Route							4.400.000 €
		25	PJ.25 Arrival Management extended to en-route Airspace							4.000.000 €
		26	PJ.26 Enhanced Terminal Airspace using RNP-Based Operations							2.400.000 €
	Enabling Aviation Infrastructure	27	PJ.27 Flight Information Exchange							6.100.000 €
		28	PJ.31 Initial Trajectory Information Sharing							17.200.000 €
	TOTAL VLD WAVE 1									42.000.000 €
TOTAL SESAR 2020 PPP (TRANSVERSAL, IR & VLDs) WAVE 1 & 2										377.500.000 €

As the PPP contribution to VLD for Wave 2 cannot be properly defined today 42M€ is allocated to projects in Wave 1 with an additional funding reserve of 20.5M for Wave 2, resulting in a total Maximum Co-financing value of 398M€ (377.5M€ + 20.5M€) in accordance with the figure in section 1.5 above.

The distribution of funding across Wave 1 and Wave 2 for Industrial Research is estimated as a 65:35 split in favour of Wave 1. The allocation of funding required to support Wave 1 is detailed in the table below:

WORK AREAS	KEY FEATURE	TOPIC	NAME OF PROJECT	INDICATIVE BREAKDOWN PER R&I MATURITY PHASE (in % of TOTAL)			INDICATIVE BREAKDOWN PER SKILLS & COMPETENCIES			MAXIMUM CO-FINANCING VALUE
				V1 PHASE	V2 PHASE	V3 PHASE	AIRBORNE SYSTEMS CONTRIBUTION	GROUND ATM SYSTEMS CONTRIBUTION	SERVICE PROVISION CONTRIBUTION	
Transversa		1	PJ.19 Content Integration				1.365.000 €	1.950.000 €	5.005.000 €	8.320.000 €
		2	PJ.20 Master plan maintenance				910.000 €	1.040.000 €	1.560.000 €	3.510.000 €
		3	PJ.22 Validation and Demonstration Engineering				455.000 €	975.000 €	3.510.000 €	4.940.000 €
	TOTAL TRANSVERSAL WAVE 1						2.730.000 €	3.965.000 €	10.075.000 €	16.770.000 €
Industrial Research & Validation	High Performing Airport Operations	4	PJ.02 Increased Runway and Airport Throughput	13%	26%	61%	3.575.000 €	5.200.000 €	5.070.000 €	13.845.000 €
		5	PJ.03a Integrated Surface Management	15%	34%	51%	5.005.000 €	5.265.000 €	1.950.000 €	12.220.000 €
		6	PJ.03b Airport Safety Nets	8%	20%	72%	2.665.000 €	2.405.000 €	3.055.000 €	8.125.000 €
		7	PJ.04 Total Airport Management	13%	33%	53%	0 €	5.850.000 €	4.615.000 €	10.465.000 €
		8	PJ.05 Remote Tower for Multiple Airports	0%	17%	83%	0 €	3.640.000 €	2.990.000 €	6.630.000 €
	Optimized ATM Network Services	9	PJ.07 Optimised Airspace Users Operations	6%	40%	54%	1.625.000 €	780.000 €	1.235.000 €	3.640.000 €
		10	PJ.08 Advanced Airspace Management	5%	27%	68%	0 €	1.040.000 €	1.690.000 €	2.730.000 €
		11	PJ.09 Advanced DCB	10%	30%	60%	0 €	2.795.000 €	4.225.000 €	7.020.000 €
	Advanced Air Traffic Services	12	PJ.01 Enhanced arrivals and departures	4%	26%	70%	5.915.000 €	5.590.000 €	6.175.000 €	17.680.000 €
		13	PJ.06 Trajectory Based Free Routing	4%	13%	83%	520.000 €	2.210.000 €	3.315.000 €	6.045.000 €
		14	PJ.10 Separation Management En-Route and TMA	12%	30%	58%	910.000 €	13.455.000 €	11.570.000 €	25.935.000 €
		15	PJ.11 Enhanced Air and Ground Safety Nets	9%	22%	68%	2.015.000 €	2.340.000 €	910.000 €	5.265.000 €
	Enabling Aviation Infrastructure	16	PJ.13 Air Vehicle Systems	15%	32%	53%	4.420.000 €	3.185.000 €	2.535.000 €	10.140.000 €
		17	PJ.14 CNS	13%	29%	58%	7.670.000 €	12.675.000 €	2.535.000 €	22.880.000 €
		18	PJ.15 Common Services	18%	30%	52%	0 €	3.770.000 €	2.665.000 €	6.435.000 €
		19	PJ.16 CWP - HMI	20%	30%	50%	0 €	7.215.000 €	4.420.000 €	11.635.000 €
		20	PJ.17 SWIM Infrastructures	17%	33%	50%	1.105.000 €	7.150.000 €	1.235.000 €	9.490.000 €
		21	PJ.18 4D Trajectory Management	5%	24%	71%	6.500.000 €	7.670.000 €	6.955.000 €	21.125.000 €
	TOTAL SESAR 2020 PROJECTS WAVE 1			11%	28%	61%	41.925.000 €	92.235.000 €	67.145.000 €	201.305.000 €
TOTAL TRANSVERSAL & PROJECTS WAVE 1							44.655.000 €	96.200.000 €	77.220.000 €	218.075.000 €
Very Large Scale Demonstrations	High Performing Airport Operations	22	PJ.28 Integrated Airport Operations (incl. TBS)							4.300.000 €
	Optimized ATM Network Services	23	PJ.24 Network Collaborative Management							3.600.000 €
	Advanced Air Traffic Services	24	PJ.23 Flexible Airspace Management and Free Route							4.400.000 €
		25	PJ.25 Arrival Management extended to en-route Airspace							4.000.000 €
		26	PJ.26 Enhanced Terminal Airspace using RNP-Based Operations							2.400.000 €
	Enabling Aviation Infrastructure	27	PJ.27 Flight Information Exchange							6.100.000 €
		28	PJ.31 Initial Trajectory Information Sharing							17.200.000 €
	TOTAL VLD WAVE 1									42.000.000 €
TOTAL SESAR 2020 PPP (TRANSVERSAL, IR & VLDs) WAVE 1										260.075.000 €

The call supporting Wave 1 for the PPP is expected to be launched during 2015 with the start of work from the beginning of 2016 to ensure a smooth transition from for the PPP from SESAR 1 to SESAR2020. The timing of the second call supporting Wave 2 is expected in 2018 to allow for an overlap in 2019 to facilitate transition of results into Wave 2 and to establish Wave 2 Demonstration activities in good time.

1.5.3 Very Large-scale Demonstrations (Open Calls)

In order to complement the Members and partners activities organised through the PPP, additional contributions will be required in order to operate large-scale demonstrations and this additional resource is expected to be secured through open calls and an allocation of 37M€ has been reserved.

The timing of calls for this activity is largely driven from the needs of the PPP demonstration activity planning which will be finalised during the call for Wave 1 of the PPP. As a consequence it is expected there will be calls in 2016 and 2019.

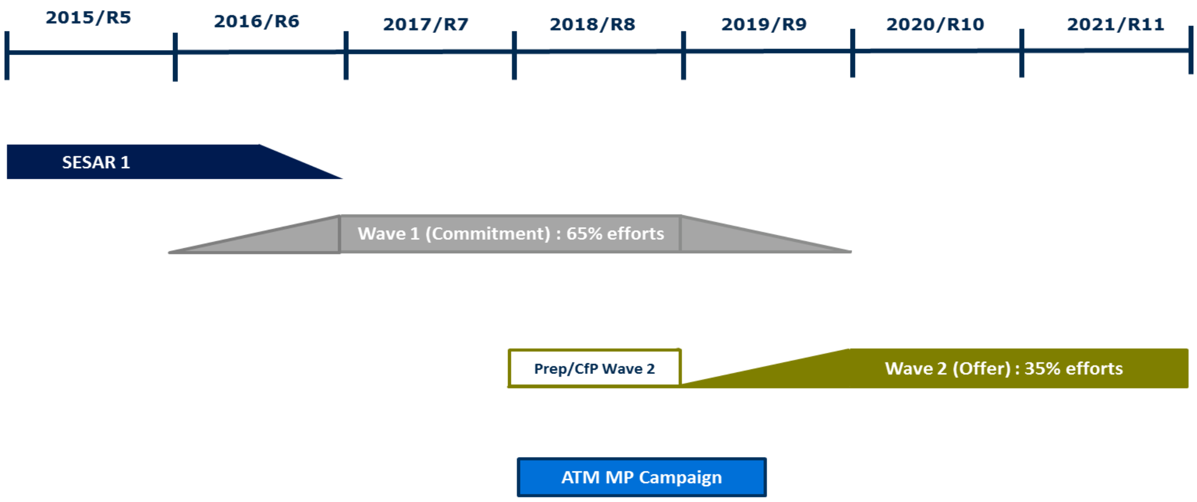
1.6 Delivering the SESAR2020 Programme

The Programme is delivered using range of instruments under Horizon2020 with Exploratory Research and part of the Very Large Scale Demonstrations being secured using open calls and the Industrial Research and remaining part of Very large Scale Demonstration using restricted calls to Members of the SESAR Joint Undertaking (SJU) Public-Private partnership (PPP), formed in accordance with the appropriate regulation.

The first call for Exploratory Research was published on 25 March 2015 and further calls will be developed in order to complete the proposed work breakdown described in this document.

The Industrial Research and Very large Scale Validation activities shall be conducted under the Public-Private partnership (PPP) arrangements with maturity towards and validation of identified SESAR Solutions being performed in a manner similar to that performed under the first SESAR Programme. This will also support ongoing feedback to the European ATM Master Plan, standards development and identification of needs for future regulation.

The SESAR2020 programme is split into two waves of call for proposals. This will enable the flexibility needed to align future research with the results of earlier work, re-assess relative priorities and ensure the best value for money for the EU and delivery against SES goals. Wave 1 will cover the period 2016-2019 and Wave 2 will be launched in 2018 to cover the period from 2019 to 2021. The high-level planning is shown below, along with indicative effort allocation (65%-35%), the links to SESAR Programme 1 and the next ATM Master Plan Campaign.



As ATM research is matured the required validation exercises are grouped into annual releases managed under an Extended Release Strategy. This strategy defines the overall planning of SESAR 2020 validation activities, the continuity necessary from the first programme, and the scope of SESAR annual Releases. This approach is summarised below, where V1 is the lowest maturity and V3 the point where very large-scale demonstration (VLD) activities can be performed on some solutions:

	SESAR 1	Wave 1			Wave 2
	R5	R6	R7	R8	
Solution PJ.XX-YY	V1	V2		V3	VLD
Solution PJ.XX-YY		V1	V2		V3
Solution PJ.XX-YY					V1 -> V3
Solution PJ.XX-YY			V1	V2	V3 & VLD

Validation reports and SESAR Solutions are published and available to wide stakeholder use.

1.7 Eligible countries and rules applicable for participation in the SESAR2020 Programme

Legal entities established in the following countries and territories will be eligible to receive funding through Horizon 2020:

1) The Member States of the European Union, including their overseas departments;

2) The Overseas Countries and Territories (OCT) linked to the Member States[1]:Anguilla, Aruba, Bermuda, Bonaire, British Virgin Islands, Cayman Islands, Curaçao, Falkland Islands, French Polynesia, Greenland, Montserrat, New Caledonia, Pitcairn Islands, Saba, Saint Barthélémy, Saint Helena, Saint Pierre and Miquelon, Sint Eustatius, Sint Maarten, Turks and Caicos Islands, Wallis and Futuna.

3) The Countries Associated to Horizon 2020[2]: the latest information on which countries are associated, or in the process of association to Horizon 2020 can be found in the online manual [3], which includes the accession process of Switzerland.

4) The following countries, except where this is explicitly excluded in the call text,: Afghanistan, Albania, Algeria, American Samoa, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, Colombia, Comoros, Congo (Democratic People's Republic), Congo (Republic), Costa Rica, Côte d'Ivoire, Cuba, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Korea (Democratic Republic), Kosovo[4], Kyrgyz Republic, Lao, Lebanon, Lesotho, Liberia, Libya, former Yugoslav Republic of Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Mauritania, Mauritius, Micronesia, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Palau, Palestine, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Samoa, Sao Tome and Principe, Senegal, Serbia, Seychelles, Sierra Leone, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan,

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[1] Entities from Overseas Countries and Territories (OCT) are eligible for funding under the same conditions as entities from the Member States to which the OCT in question is linked.

[2] Signed an agreement with the Union as identified in Article 7 of the Horizon 2020 Regulation.

[4] This designation is without prejudice to positions on status and is in line with UNSCR 1244/99 and the ICJ opinion on the Kosovo declaration of independence.

Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Tunisia, Turkey, Turkmenistan, Tuvalu, Uganda, Ukraine, Uzbekistan, Vanuatu, Uruguay, Venezuela, Vietnam, , Yemen, Zambia, Zimbabwe.

International European interest organisations [5] will also be eligible to receive funding from Horizon 2020.

Legal entities established in countries not listed above will be eligible for funding when such funding is explicitly foreseen in the relevant call text.

In addition, legal entities established in countries not listed above and international organisations will be eligible for funding:

A) When funding for such participants is provided for under a bilateral scientific and technological agreement or any other arrangement between the Union and an international organisation or a third country,

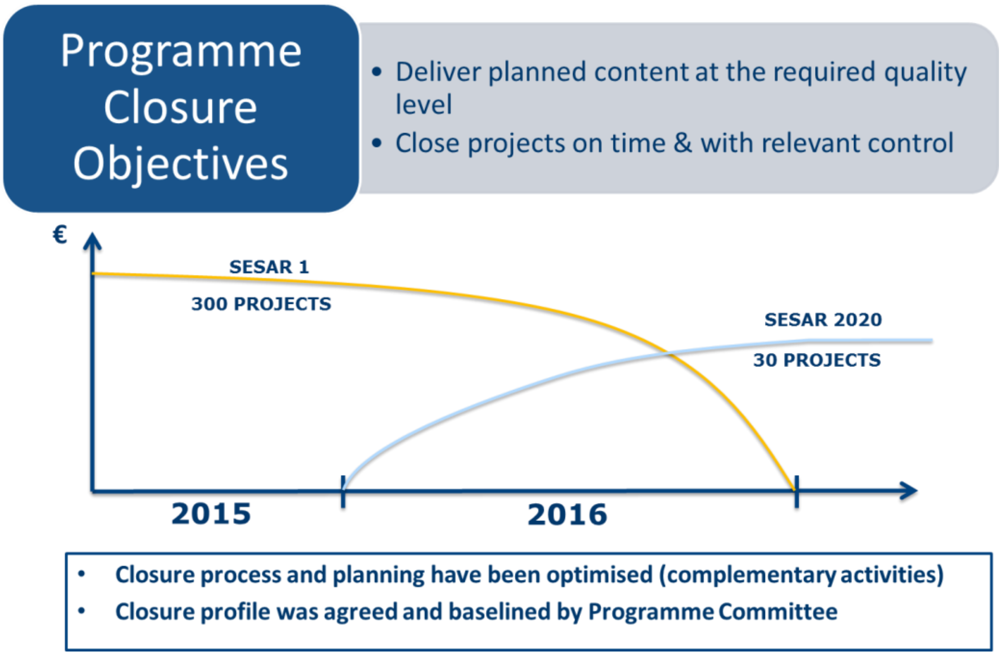
or

B) When the SJU deems participation of the entity essential for carrying out the action funded through Horizon 2020. This means in particular for SESAR when:
   (a) The non-EU country concerned has signed at least one aviation agreement with the European Union;
   (b) The participation of the entity concerned adds value to SESAR 2020 and to the European Union actions. Such added value shall be assessed on the basis of the following elements:
      - Operational and technical continuity of the European airspace (in particular, but not limited to, in the context of the Functional Airspace Blocks – FABs): this concerns, in particular, countries which have signed the ECAA Agreement and Iceland, Norway, Morocco, Switzerland. These countries are part of the Single European Sky and therefore they should be fully part of SESAR;
      - Technological partnerships: this concerns in particular countries participating in Research Framework Programmes, which are natural technological partners of Europe; Organisations or undertakings around the world which have a technological partnership with European industry should also be considered in this category, in order to promote global interoperability;
      - Market access: For emerging countries which will need to invest into new technologies; These countries represent considerable market opportunities for European aviation industry;
      - Competence/expertise of the third country entity;
      - Access to research infrastructure, to particular geographical environments and to data.
   (c) An equivalent programme to SESAR exists in the non-EU country; reciprocity in terms of access for European industry to equivalent funding possibilities is an absolute necessity.
   (d) The transfer of technological know-how should benefit the European society in terms of building European technological competence and creating jobs in Europe. Transfers of know-how to third country members should be managed by the European members.

1.8 SESAR 1 Closure

Closure of the SESAR 1 programme will take place during 2016 and in parallel with the launch of SESAR2020. This will facilitate as far as possible the seamless transition of work to be done as part of the extended SESAR Joint Undertaking. The SJU was extended by Council Regulation 721/2014 of 16 June 2014 (SJU Amending Regulation) in order to complete the execution of the European ATM Master Plan relating to the remaining elements of the development phase.

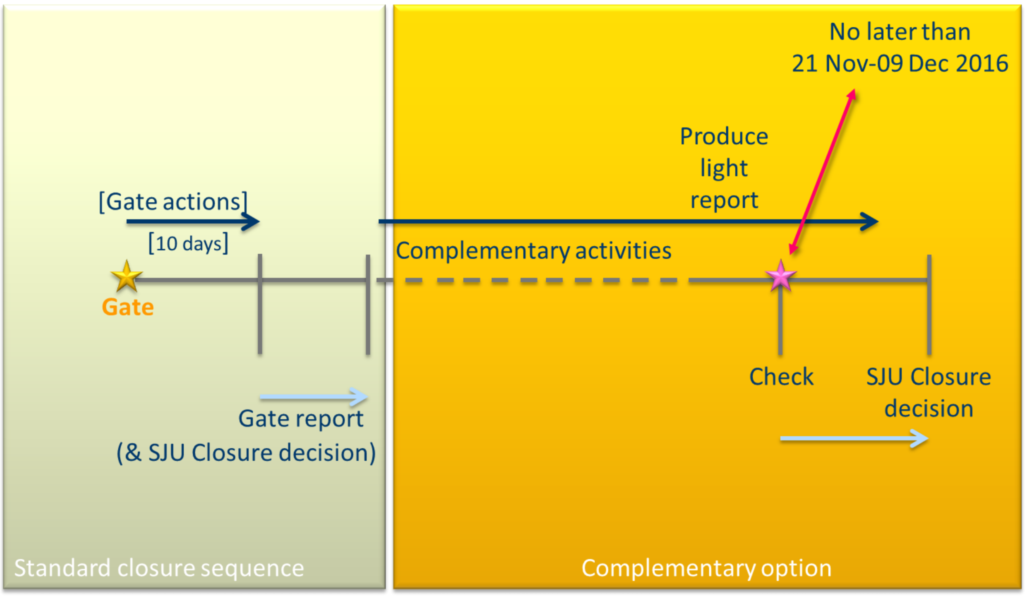
The objectives SESAR 1 closure includes maintaining content quality while being closed on time and with all the necessary controls in place. In terms of closure profile for the 2016 transition, this is illustrated below.



- Deliver planned content at the required quality level
- Close projects on time & with relevant control

- Closure process and planning have been optimised (complementary activities)
- Closure profile was agreed and baselined by Programme Committee

This means that a closure plan has been developed within the SESAR 1 governance to introduce an agreed process and timeline, as well as establishing the means of transferring results through dedicated transition activities called ‘complementary activities’.



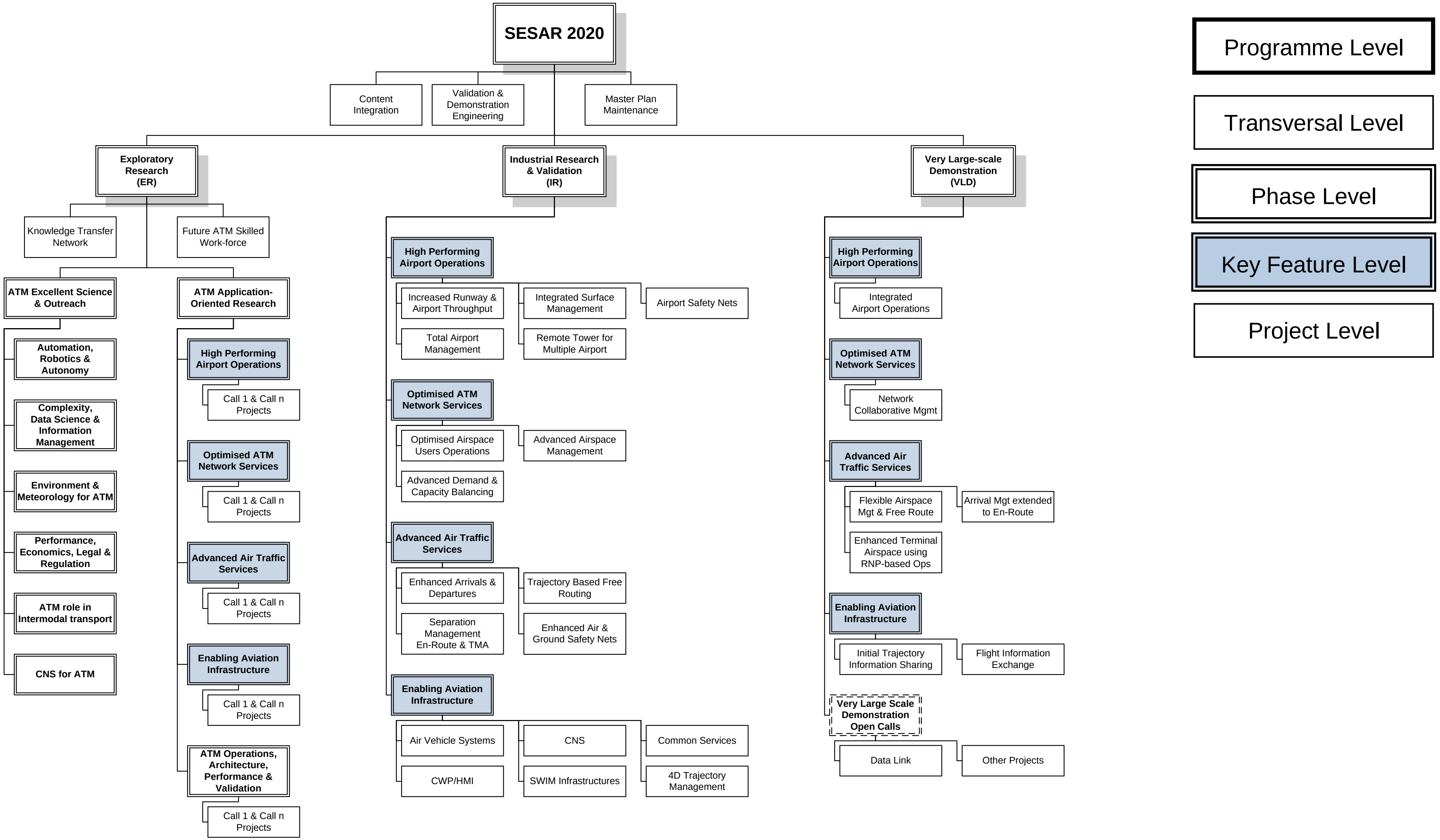
This combination of SESAR1 project management and project governance arrangement in combination with defined activities to prepare transition material for the launch of related projects in SESAR2020 enables the managed closure of SESAR 1 along with the organised launch of SESAR2020. The overall closure profile is being monitored and matched with the planned ramp-up profile and through the SJU programme governance the contribution to this activity from each of the Members in order to minimise the disruption to the continuity of SESAR Development activities.

Not all projects will continue into SESAR2020 and Release 5 finalisation will also take place in 2016 from around a total 38 Exercises (2015-16) covering up to 33 SESAR Solutions, of which 15 of these have deployment dependencies through the Pilot Common Project defined by the EC for the SESAR Deployment Manager.

2 SESAR2020 Programme – Scope

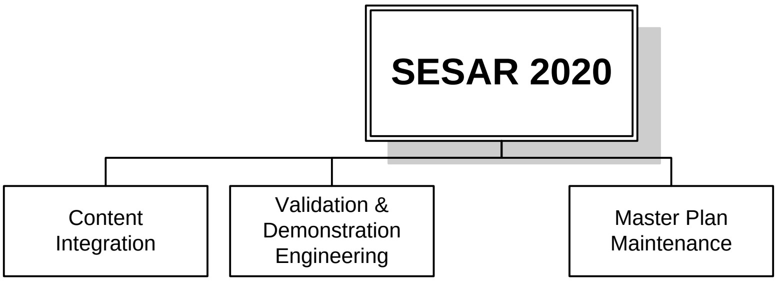
2.1 Structuring the Programme

Using the agreed principles, research challenges and key features for the programme the Work Breakdown Structure (WBS) for SESAR Programme is pictured below. It includes the 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 Content Integration

The project will coordinate and integrate operational and technical solutions, and as such to support and guide the processes to ensure their completeness, consistency and coherency from a holistic perspective as expressed in the SESAR CONOPS. The content Integration activities will also cover the maintenance and support of the performance framework and ensuring its applicability by the projects. These activities will provide support to the activities that monitor the programme and that will lead to the further decision making necessary by SJU management and SESAR governance.

2.2.2 Validation & Demonstration Engineering

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).

This project is focussed on delivering against three key aims:

- The development and maintenance of processes, methods, tools and training for SE data Management (based on a Data centric approach) allowing to capture SE data in a structured way and ensuring consistency, coherence and coverage analysis at Programme level;
- The maintenance of V&VPs, V&VIs and Demonstration Platform Development Methodology, providing support and monitoring its correct application across the programme;
- The development of technical specifications, interoperability requirements and conformance criteria supporting the communalization of validation tools and interoperability solutions that are applicable for the different simulators, tools and V&Vis

2.2.3 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.

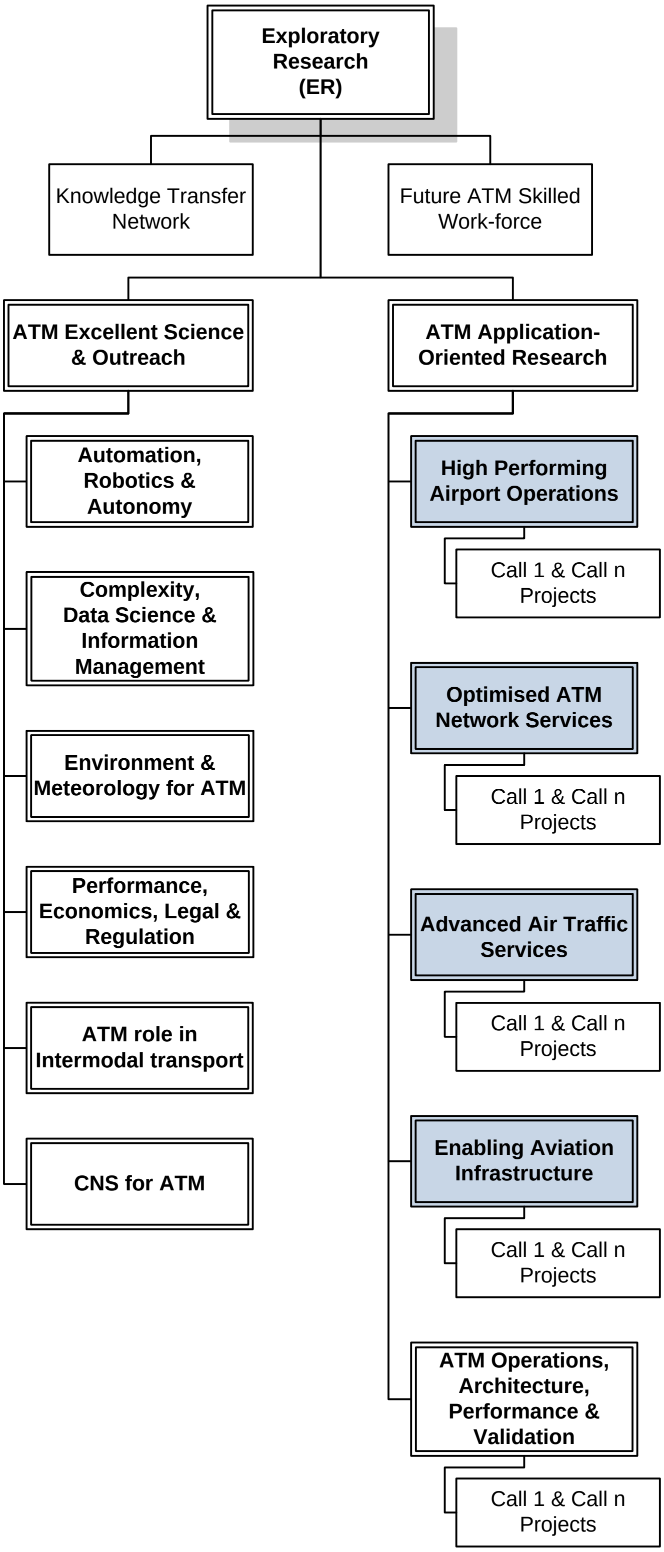
The maintenance and execution of the European ATM Master Plan, as defined in the SJU Regulation, are consequently at the heart of the SJU activities. Selected results of

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 support the delivery of up-to-date maintenance of the ATM MP and the alignment of its three levels. This includes ensuring that the ATM performance needs and expectations are correctly established at the highest level and can flow into the programme to drive R&I and deployment prioritisation.

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

The Transversal area includes ‘Future European ATM skilled work-force’ that 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 as well as establishing effective Knowledge transfer mechanisms.

The assessment and coordination of project results though the knowledge transfer network 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.

2.3.2.1 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 (ground and airborne systems) and 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. Indeed, ATM currently relies on high levels of human intervention for essential functions - in this respect it lags behind 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.

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.

In a more highly automated operating environment consideration of procedures and technologies for risk mitigation and contingency must be adequately considered, examples of this could be during operation of remotely piloted or automated vehicles where credible system failures can occur and safety, efficiency and overall operations integrity/performance must be managed and where possible maintained during and after such failures. Consequently this research topic can be the placeholder to develop required enablers for Very Low Level flight of RPAS.

2.3.2.2 Complexity, Data Science & Information Management

The research activities under this theme will address complexity science, data science and information management and their applications in ATM. Complexity science will deal with the application of complexity theory in the ATM domain and will therefore contribute to 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 optimizing planning and execution of ATM.

2.3.2.3 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 look at apply them to the environment and meteorology domains in the context of the future ATM evolution.

2.3.2.4 Performance, Economics, Legal & Regulation

In recent years, the importance of understanding the evolution of the ATM service market structure, the need to minimize airborne costs, use of cost-effective new business and pricing models has become evident. The research performed under this area will contribute to the wider innovation and competitiveness of the European ATM industry, therefore contributing to Challenge 2 of Flight Path 2050.

The links between economics, the legal and the regulatory frameworks and the research performed in each subject are close; this means that the implications of change in one area have to be integrated across the whole, otherwise change in ATM can be unnecessarily blocked.

2.3.2.5 ATM role in Intermodal Transport

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, it is envisaged that complementary research will be performed linking to activities launched by the EC and potentially other transport areas (i.e. rail, road, water) to ensure interoperability and delivery of complementary services to realise cross-modal performance as described by the EU transport policy documents.

2.3.2.6 CNS for ATM

Communication, Navigation and Surveillance (CNS) are not exclusively an ATM subject, therefore the study and use, or adaptation, of new technologies being developed outside ATM to needs identification and analysis of the safety, performance and security implications for the ATM system before a specific ATM application can be proposed.

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.

This part of Exploratory Research will be structured around the four key features of the programme and the transversal needs to ensure there is a flow of ideas and results in a structured manner across the whole programme.

2.3.3.1 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.

2.3.3.2 Optimised ATM Network Services

The Optimised ATM Network Services 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.

2.3.3.3 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.

2.3.3.4 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 the 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 center 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. Consequently areas that include, CNS, SWIM, Trajectory Management, Common Services, the human role and interactions and the Air

Vehicle Systems should be considered in a coordinated way for application across the whole of ATM.

2.3.3.5 ATM Operations, Architecture, Performance & Validation

This research area will focus on extending the SESAR operational concept, ensuring robust transition and evolution of architecture, the safety and security implications as well as ensuring the delivery of performance to meet future needs. Consideration must also be given to delivering suitable means of assurance for validation as well as evidence to support decision-making, case-based arguments and strategic thinking.

Introduction of new vehicle types and operations going beyond todays ‘air vehicle and pilot’, ‘ground system and controller’ viewpoint will be considered, although consideration of introduction through a mixed operating environment and the necessary transition must be considered.

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

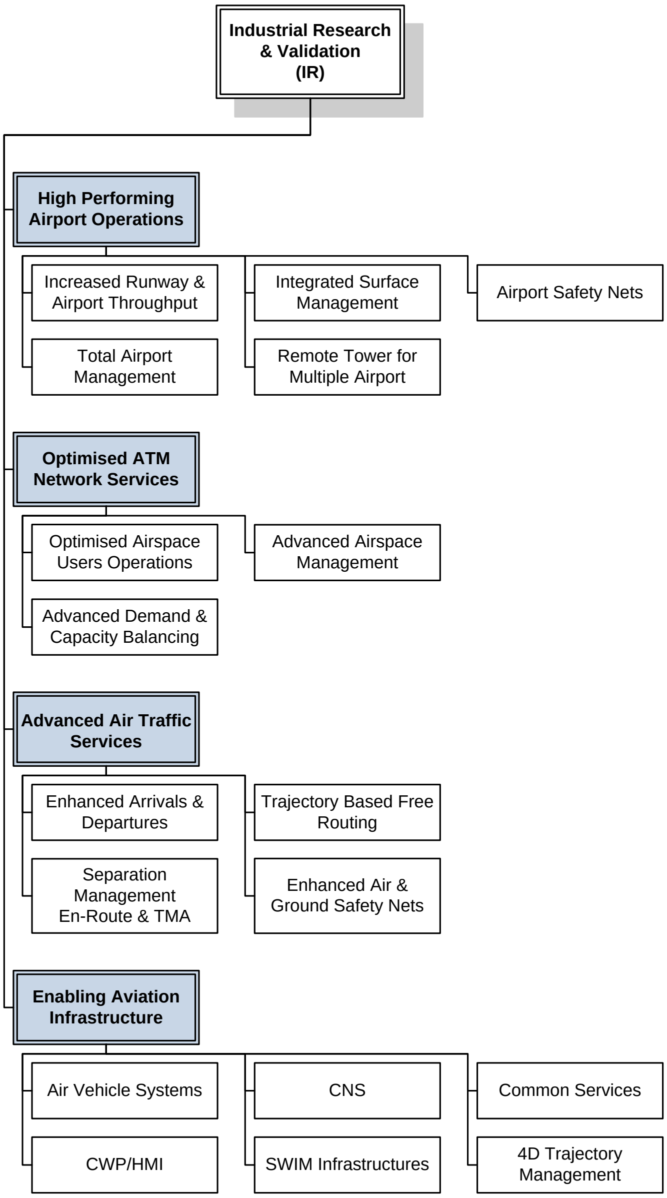
2.4 Industrial Research & Validation (From TRL2-6)

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 Services
- Advanced Air Traffic Services
- Enabling Aviation Infrastructure

The scope of these 4 key features are decomposed in two waves each targeting specific validation timeframes (2016-2019 for Wave 1 and 2019-2021 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.



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.

This key feature will be developed through the following projects

2.4.1.1 Increased Runway and Airport Throughput

The project aims at delivering the following solutions:

- Wake turbulence separation optimisation
- Enhanced arrival procedures
- Minimum-Pair separations based on RSP
- Independent Rotorcraft operations at the Airport
- Improved access into secondary airports in low visibility conditions
- Traffic optimisation on single and multiple runway airports
- Enhanced Runway Condition Awareness
- Enhanced Terminal Area for efficient curved operations

2.4.1.2 Integrated Surface Management

The project aims at delivering the following solutions:

- Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing
- Enhanced navigation and accuracy in LVC on the airport surface
- Enhanced Visual Operations
- Surface operations by RPAS

2.4.1.3 Airport Safety Nets

The project aims at delivering the following solutions:

- Enhanced Airport Safety Nets for Controllers
- Conformance monitoring safety net for Pilots
- Traffic alerts for pilots for airport operations
- Safety support tools for runway excursions

2.4.1.4 Total Airport Management

The project aims at delivering the following solutions:

- Enhanced Collaborative Airport Performance Planning and Monitoring
- Enhanced Collaborative Airport Performance Management

2.4.1.5 Remote Tower for Multiple Airports

The project aims at delivering the following solutions:

- Remotely Provided Air Traffic Service for Multiple Aerodromes
- Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules

2.4.2 Optimised ATM Network Services

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.

This key feature will be developed through the following projects.

2.4.2.1 Optimised Airspace Users Operations

The project aims at delivering the following solutions:

- AU Processes for Trajectory Definition
- AU Fleet Prioritization and Preferences (UDPP)
- Mission Trajectory Driven Processes
- AU Trajectory Execution from FOC perspective

2.4.2.2 Advanced Airspace Management

The project aims at delivering the following solutions:

- Management of Dynamic Airspace configurations
- Dynamic Airspace Configuration supporting moving areas

2.4.2.3 Advanced Demand & Capacity Balancing

The project aims at delivering the following solutions:

- Network Prediction and Performance
- Integrated Local DCB Processes
- Collaborative Network Management Functions

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).

This key feature will be developed through the following projects.

2.4.3.1 Enhanced Arrivals & Departures

The project aims at delivering the following solutions

- Extended Arrival Management with overlapping AMAN operations and interaction with DCB
- Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA
- Dynamic and Enhanced Routes and Airspace
- Airborne Spacing Flight Deck Interval Management
- Enhanced Rotorcraft and GA operations in the TMA
- Approach Improvement through Assisted Visual Separation

2.4.3.2 Trajectory Based Free Routing

The project aims at delivering the following solutions:

- Optimized traffic management to enable Free Routing in high and very high complexity environments
- Management of Performance Based Free Routing in lower airspace

2.4.3.3 Separation Management En-Route and TMA

The project aims at delivering the following solutions:

- High Productivity Controller Team Organisation
- Flight Centred ATC
- Collaborative Control
- Improved Performance in the Provision of Separation
- Advanced Separation Management
- Ad Hoc Delegation of Separation to Flight Deck
- IFR RPAS Integration
- Generic' (non-geographical) Controller Validations

2.4.3.4 Enhanced Air and Ground Safety Nets

The project aims at delivering the following solutions:

- Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations – ACAS Xa
- ACAS for Commercial Air Transport specific operations – ACAS Xo
- Airborne Collision Avoidance for Remotely Piloted Aircraft Systems - ACAS Xu
- Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp
- Enhanced Ground-based Safety Nets adapted to future operations

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.

Currently, RPAS operations are not routinely integrated into the ATM environment and 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 a national level. Therefore, specifically included in this key feature is the overall integration of RPAS vehicles into the ATM system. The successful integration of Remotely Piloted Aircraft Systems (RPAS), General Aviation (GA) and Rotorcraft with the Commercial Aviation is a key issue for the SES

This key feature will be developed through the following projects

2.4.4.1 Air Vehicle Systems

One of the purposes of the project will be to ensure a cross-fertilisation of technical solutions between RPAS and GA/R and this will be obtained thanks to a technical coordination between the project areas. This project shall focus on technical aspects that are unique to RPAS and GA/R, consistently with the user needs and the operational requirements expressed in other SESAR2020 projects and, for the GA/rotorcraft topic, in accordance with the output of SESAR 1 project 4.10.

The project aims at delivering the following solutions:

- Airborne Detect and Avoid systems
- GA/R Specific Communication Systems
- GA/R Specific Navigation Systems
- GA/R Specific Surveillance Systems
- GA/R Information management Systems

2.4.4.2 CNS

The project aims at delivering the following solutions:

- CNS environment evolution
- CNS Avionics integration
- CNS Ground segment integration
- FCI Terrestrial Data Link
- Future Satellite Communications Data link
- FCI Network Technologies incl. voice solution and military interfacing
- Development of new services similar to FIS-B to support ADS-B solutions for General Aviation
- Completion of AeroMACS development
- GBAS
- Multi Constellation / Multi Frequency (MC/MF) GNSS
- Alternative Position, Navigation and Timing (A-PNT)
- Surveillance Performance Monitoring
- New use and evolution of Cooperative and Non-Cooperative Surveillance

2.4.4.3 Common Services

The project aims at developing Common Support Services. These services are providing ATM capabilities in the same form to consumers that might otherwise have been undertaken themselves, thus reducing fragmentation, enabling economies of scale, facilitating synergies and improving safety.

With new systems being developed and introduced over the next decade or so, several of the services for collecting, processing, enhancing or distributing data could be implemented as Common Support Services. The rationale for using common services is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM.

The development of Common Support Services will also result in a more flexible, scalable interface between the system infrastructure and the ANS operations, allowing operational stakeholders to plug in their services where they are needed in the most effective, efficient and economical manner. These may be provided on a competitive basis primarily to operational stakeholders, on a non-local basis by one or more service providers.

The project aims at delivering the following solutions:

- Sub-regional Demand Capacity Balancing service
- Delay Sharing
- Trajectory Prediction service
- Data Centre Service for Virtual Centres
- Static Aeronautical Data Service
- Aeronautical Digital Map Service

2.4.4.4 CWP/HMI – Controller Working Position/Human-Machine Interface

The project aims at delivering the following solutions:

- Virtual Centre Concept
- Workstation, Controller productivity

2.4.4.5 SWIM Infrastructure

The project aims at delivering the following solutions:

- SWIM TI Purple Profile for Air/Ground Advisory Information Sharing
- SWIM TI Federated Identity Management
- SWIM TI Green Profile for G/G Civil Military Information Sharing
- SWIM TI Common runtime registry
- SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing

2.4.4.6 4D Trajectory Management

The project aims at delivering the following solutions:

- Mission Trajectories
- Integration of trajectory management processes in planning and execution
- Management and sharing of data used in trajectory (AIM, METEO)
- Performance Based Trajectory Prediction

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

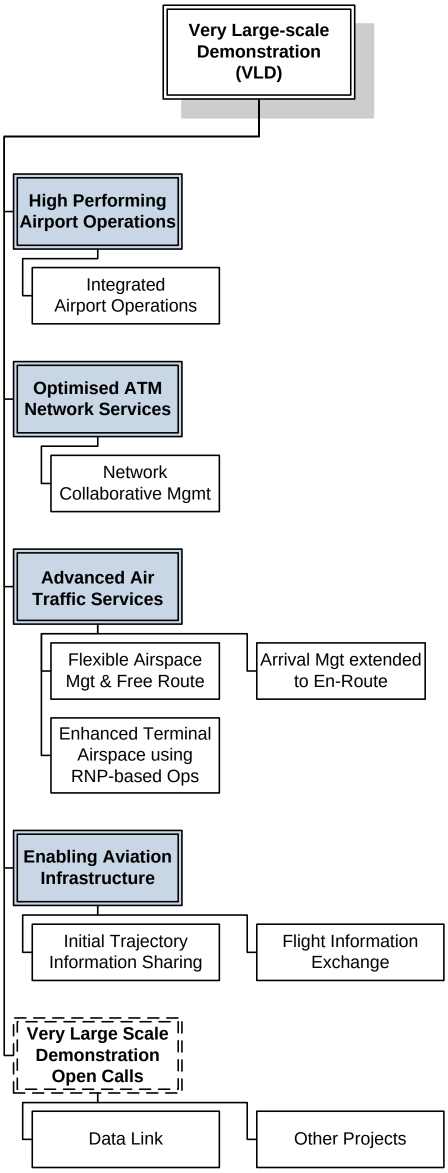
This section presents the content of the Very Large Scale Demonstration (VLD), presenting the related high-level project descriptions.

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.



2.5.1 High Performing Airport Operations

2.5.1.1 Integrated Airport Operations

The project will organise demonstrations focussed on functionalities that enhance Airport Integration and Throughput that facilitate the provision of approach and aerodrome control services by improving runway safety and throughput, enhancing taxi integration and safety and reducing hazardous situations on the runway.

2.5.2 Optimised ATM Network Services

2.5.2.1 Network Collaborative Management

This project will organise demonstrations that improve the European ATM network performance, notably capacity and flight efficiency through exchange, modification and management of trajectory information. Flow Management will move to a Cooperative Traffic Management (CTM) environment, optimising the delivery of traffic into sectors and airports and the need for Air Traffic Flow and Capacity Management (ATFCM) measures.

2.5.3 Advanced Air Traffic Services

2.5.3.1 Flexible Airspace Management & Free Route

This project will organise demonstrations covering combined demonstration of Flexible Airspace Management and Free Route that will enable airspace users to fly as closely as possible to their preferred trajectory. It will further allow operations that require segregation, for example military training, to take place safely and flexibly, and with minimum impact on other airspace users.

2.5.3.2 Arrival Management Extended to En-Route Airspace

This project will demonstrate extended Arrival Management to en-route Airspace (AMAN horizon extended from 100-120 nautical miles to 180-200 nautical miles from the arrival airport). Traffic sequencing may be conducted in the en-route and early descent phases. Air traffic control (ATC) services in the TMAs demonstrating AMAN operations will coordinate with Air Traffic Services (ATS) units responsible for adjacent en-route sectors.

2.5.3.3 Enhanced Terminal Airspace using RNP-based Operations

This project will organise demonstrations including the demonstration of environmental friendly procedures for arrival/departure and approach using PBN in high-density TMAs.

2.5.4 Enabling Aviation Infrastructure

2.5.4.1 Initial Trajectory Information Sharing

This project will demonstrate initial Trajectory Information Sharing (i4D) consisting of the improved use of target times and trajectory information, including where available the use of on-board 4D trajectory data by the ground ATC system and Network Manager Systems, implying fewer tactical interventions and improved de-confliction situation.

2.5.4.2 Flight Information Exchange

This project will demonstrate Flight information exchange during the pre-tactical and tactical phases by ATC systems and Network Manager. Operational stakeholders will demonstrate exchange of flight information using SWIM profiles. This demonstration will ensure that FO-IOP works in the environment of several ACCs, is sufficiently reliable, meets performance expectations and supports the ACCs daily operational functions and procedures.

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.

The scope includes a project on data-link and others as the need dictates.

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 SESAR2020 Project Descriptions - Transversal Activities

B.1 Content Integration (PJ19)

PJ19	Content Integration

Problem Statement

The SESAR research, development and validation activities shall serve one common concept, which elaborates transitional changes to the functional ATM architecture in order to mirror the conceptual evolution towards the SESAR CONOPS and to contribute to the Union-wide performance targets as defined by the SES Performance Scheme. Recognising that not all related research activity is funded and managed by the SJU then it is necessary to also establish a clear focal point for coordination on research activities outside of SESAR that have reason to be coherent with SESAR and therefore integrated in terms of achieving interoperability, architecture coherence and performance.

A successful approach to achieve this necessitates a Content Integration perspective:

- Executing the steering as provided and endorsed by SJU management and SESAR governance and integration of develop content (SESAR CONOPS, SESAR Functional Architecture, Information and Services);
- Creating collaborative platform for solving operational and technical challenges;
- Ensuring the coherence within and between the different SESAR 2020 projects
- Ensuring alignment with the expectations outlined in the European ATM Master Plan with regards to performance and transition to deployment.
- Ensure alignment of SESAR with other SES-related dependent activities and related research, including Cyber Security, RPAS, and Air Vehicle System developments in Clean Sky.

High level solution description

The SESAR 2020 Programme requires guidance and steering to achieve the objectives of the Master Plan. While the decisions will be taken by SJU management and SESAR governance, there is a need for content integration activities that will support it.

Under SJU leadership and by closely involving other transversal projects and Solution and Enabling projects (via ATM focal points, according to a defined process as documented in the SESAR 2020 Guidance, the “Content Integration” (CI) activities will aim to coordinate and integrate operational and technical solutions, and as such to support and guide the processes to ensure their completeness, consistency and coherency from a holistic perspective as expressed in the SESAR CONOPS (e.g. content issue, integration of content feedback from ATM solution projects). The content Integration activities will also cover the maintenance and support of the performance framework and ensuring its applicability by the projects. These activities will provide support to the further decision making necessary by SJU management and SESAR governance.

In addition Content Integration activities will support the Maturity Gates activities in terms of allocating experts for reviewing the material made available for confirming the maturity and performance levels achieved by the ATM Solutions.

The content integration activity will be enabled and supported by a common framework to secure the continuous collaboration, a controlled and transparent change process to support reporting for informed decision making. The maintenance of the Framework is considered as a dedicated area within Content Integration.

Close coordination will be ensured with the Master Plan Maintenance project to ensure providing the adequate support and required expertise for Master Plan updates.

Close coordination will be ensured with the external organisations undertaking related research projects to ensure providing the adequate support and required expertise for operations, systems & services, performance management, architecture and Master Plan updates.

More details about the life cycle and process (who, how & when) and about the responsibilities to conduct the activities are outlined in the Introduction to the SESAR 2020 Programme Execution.

The Member(s) contributing to the Architecture modelling (EATMA) will act as repository manager based on MEGA tool. The SJU retain full rights and ownership on the content of the architecture database. The Content Integration project through its contributing member(s) will provide a virtualised desktop environment providing suitably authorised and trained users remote access to the repository. The Content Integration project will have to maximise the overall effectiveness and value of the architecture modelling activity by ensuring that it meets the needs across the Programme and for the SJU staff to undertake its responsibility.

When required and upon SJU request, the Content Integration project will deliver the elements allowing the SJU to continue the Architecture Modelling operations, in particular:

- The populated database;
- The set of tool configuration and customisation files.

The Content Integration can further be broken down into the following 4 domains of activities each managed by an activity manager:

1. **ATM operations**

This Activity is led by a dedicated TA Activity Coordinator

The envisaged changes to business, operations and technology need to be brought together (collected and integrated), dependencies need to be identified and consistency and coherency have to be assured. This for the benefit of as well the projects as the programme, the stakeholders and the management of the programme in order to be able to take informed decisions.

The following areas will be covered by the ATM operations :

- Preparation of Operations related Steering Principles as provided by SJU management and SESAR governance
- Integrate the operational solutions defined by the SESAR Solution projects into the SESAR 2020 concept of operations in Europe for all stakeholders in order to meet the objectives outlined in the European ATM Master Plan and to assure a consistent understanding of the operational changes along with the capabilities required.
- Maintain and update a high level Validation Strategy (VALS) consistent with ATM Master Plan (e.g. targeted operating environments) for the different Key Features defining the validation approach apportioned per SESAR solution, including the need for integrated validation and possibly demonstration activities to ensure the necessary deployment orientation of SESAR validation activities.
- Analyse proposed Changes to the Operations (e.g. Operational Improvement Change Requests, Procedural Enablers) and table results (including the assessed performance impact) for decision to be made by SJU management and SESAR governance.
- Support the SJU in the analysis of issues/risks that cannot be resolved at SESAR Solution project level (problem statement, detailing the impact, outlining action plans) and table results for decision to be made by SJU management and SESAR governance.
- Preparation of ATM Operations related Steering Principles as provided by SJU management and SESAR governance
- Preparation of regular and ad-hoc Operations domain related reports needed to support the decision making processes and groups

2. **ATM systems and services**

This Activity is led by a dedicated TA Activity Coordinator

- Functional Architecture:
    - Integrate the technical solutions architecture produced by the SESAR solution projects it into the

  - ATM functional architecture (ADD) that shall map the ATM solutions to the capability configurations in terms of enablers.
  - Analyse proposed Changes to the ATM systems (e.g. System and Standard Enablers Change Requests) and table results (including the assessed performance impact) for decision to be made by SJU management and SESAR governance
  - Analyse issues/risks that cannot be resolved at SESAR Solution level (problem statement, detailing the impact, outlining action plans) and table results for decision to be made by SJU management and SESAR governance and Include implementation /deployment options based on results from the projects
  - Prepare the architecture material needed to support the decision making processes and groups
- Services:
  - Analyse proposed Changes to the services and table results for decision to be made by SJU management and SESAR governance.
  - Coordinate and maintain the service roadmap in order to facilitate, coordinate and prioritize the development of services
  - Integrate and Maintain the ISRM content to ensure interoperability and analyse proposed Changes to Information Service Reference Model (ISRM) and table results for further decision to be made by SJU management and SESAR governance
- Information:
  - Support SJU with the development of the ICAO information architecture which will ensure the efficient and consistent use of ATM information and global interoperability.
  - Following R&D activity, analyse proposed changes to AIRM in accordance of the defines change content management process
  - Research, develop and validate topics and new content for inclusion in the ATM Information Reference Model (AIRM)
  - Update and maintain the inventory of SESAR terms (SESAR Lexicon), with the corresponding definition, to harmonize their use in the Work Programme
- Preparation of System and Services related Steering Principles as provided by SJU management and SESAR governance
- Preparation of regular and ad-hoc System and Services domain related reports needed to support the decision making processes and groups
- Preparation of a synthetic view of High Level Architecture evolution options
- Coordination of Cyber-security activities and guidance provided across all projects in order to prepare SESAR for compliance with the recommendations of the Cyber Security study.

3. Performance Management

This Activity is led by a dedicated TA Activity Coordinator

Although the responsibility of conducting the performance assessments and CBAs lies with the SESAR 2020 projects, there is a need to follow continuously the process of performance evaluation to ensure alignment with expectations outlined in the European ATM Master Plan and that performance results can be exploited not only at local level but also for decision making at European level.

- Performance Framework:
  - Maintain, update when need be the Performance Framework to set and assess performance at network level: metrics, models, methods, processes and related guidelines and tools (e.g. Safety, Security/cyber security, Human performance).
  - Derive and define the Validation Targets applicable at SESAR solution level.

  - Ensure and maintain consistency with the SES Performance scheme Key Performance Areas and Indicators

- Performance Assessment: Consolidation
  - Review and consolidate the performance assessment of the SESAR projects to derive performance implication at ECAC level, compare them with the targets and perform yearly gap analysis.
  - Support European ATM Master Planning activities in aggregating the performance evidences to build Business Cases to support transition to deployment.
- Performance Quality Assurance:
  - Provide the SESAR Solution projects with training and support for the application of the relevant harmonized approach (Reference and Guidance Material).
  - Provide the SESAR Solution projects with training and support for performance assessment, ensure the application of standardised assessments
  - 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.
- Preparation of regular and ad-hoc performance domain related reports needed to support the decision making processes and groups

4. **Support and Evolution of the Content Development Framework (EATMA – European ATM Architecture)**

This Activity is led by a dedicated TA Activity Coordinator

- Support; adapt and update the architecture framework to fit the need of SESAR2020 (e.g. modifying the architecture rules, meta-model, processes, and practices); maintain the operational, service, information and functional architecture meta-models.
- Develop guidance in function of the usage of the Framework by the Solution and Enabling Projects
- Organise and Support the Content Development related Change Management Process
- Preparation of relevant Architecture Steering Principles as provided by SJU management and SESAR governance
- Provide training for the application of the architecture framework and the use of the tool(s)
- Consolidate Change Requests to the Integrated Roadmap (ATM Master Plan Level 2 Data Set) on the basis of analysis performed by experts from ATM operations, systems, Services and Performance management areas and following decision made through the change management process.
- Manage changes and control access to the EATMA Repository and its documentation.

Dependencies with other Projects or external activities if required

There is particularly strong dependency with the Master Plan Maintenance project in the sense that the Planning View will be maintained through a collaborative process including Content Integration and Master Plan Maintenance projects in line with Change Management as defined in the execution Guidance and to be further refined before the start of the Programme.

As indicated in the section below, many of the deliverables are produced by collecting, assessing and consolidating contributions from Solution and Enabling Projects. To do this the content execution activities are done with the effort from each project through their ATM focal points.

Dependencies exist with external projects being managed by entities including ESA, Clean Sky JU etc.

Deliverables

The following deliverables are identified per Activity and will be submitted on a yearly basis :

ATM Operations :

- CONOPS
- VALS
- Steering Principles
- AIRM

Systems & Services

- ADD
- Service Roadmap
- ISRM
- SESAR Lexicon updates

Performance Management

- Performance Framework
- Validation Targets
- Consolidated Performance Assessment and Gap Analysis

Support and Evolution of the Content Development Framework (EATMA)

- EATMA Portal and model release notes (yearly delivery)
- EATMA guidance material and report
- Update to Guidance, Training & Coaching Materials
- Consolidated report on Change Requests to the Integrated Roadmap (ATM Master Plan Level 2 Data Set)
- Yearly Life cycle Reference material containing:
    - Programme Strategic direction as set and endorsed by SJU management and SESAR governance.
    - Design Principles stemming from the ATM MP Performance Needs, CONOPS, Performance Report and Gap Analysis and Maturity Report.
    - Corrective Actions: Issues pending from previous iteration (yearly in December), e.g. identified inconsistencies etc.
- Report on key programme resolution of issues/risks that cannot be resolved at SESAR Solution level (problem statement, detailing the impact, outlining action plans)

B.2 Validation & Demonstration Engineering (PJ22)

PJ.22 Validation and Demonstration Engineering

Problem Statement

In SESAR 1, WP03 was responsible for the Validation & Verification Infrastructures (V&VI) and Platforms (V&VP) development required for supporting SESAR Validation Exercises.

The scope comprised not only the development of the System Engineering (SE) methodologies to develop V&VIs and V&VPs but also the actual specification, development, verification and acceptance of such infrastructure to host the planned validation activities in the cases where WP3 support was requested. However, the application of WP03 methodology and the development of V&VIs and V&VPs by WP03 was just an option for primary projects. This led to a different level of information available across the programme regarding the different V&VIs and V&VPs development.

SESAR 1 in general (and WP03 in particular) has been very focused on V3 maturity level. SESAR 2020 will additionally pay further attention to V2 and to activities beyond V3 in preparation for industrialization (Very Large Scale Demonstration (VLSD)) that have not been addressed by WP3 related activities in SESAR1.

WP03 played a key role in System Engineering Review 2 (SE#2) in SESAR 1 that focused on assessing the readiness for the execution of all validation exercises part of a given Release. The experience gained during SE#2 highlighted that WP03 support, when provided, resulted in a better understanding on the limitations of the V&VPs and their potential impact on the success of the validation exercises compared to the cases where WP03 support was not requested.

Primary Projects in SESAR 1 did not use the SESAR templates consistently and therefore the information delivered to the SJU was not provided in a standard way that would have eased its consistency and quality analysis. In particular, they did not always follow the SESAR Requirements and V&V guidelines when producing their deliverables and therefore coverage matrixes couldn’t be produced showing traceability between operational & performance requirements vs. technical requirements, between validation objectives vs. operational & performance requirements etc.

On top of this, in SESAR 1, the SE data was captured via word templates. This required a significant effort to extract the information and to coordinate the necessary updates.

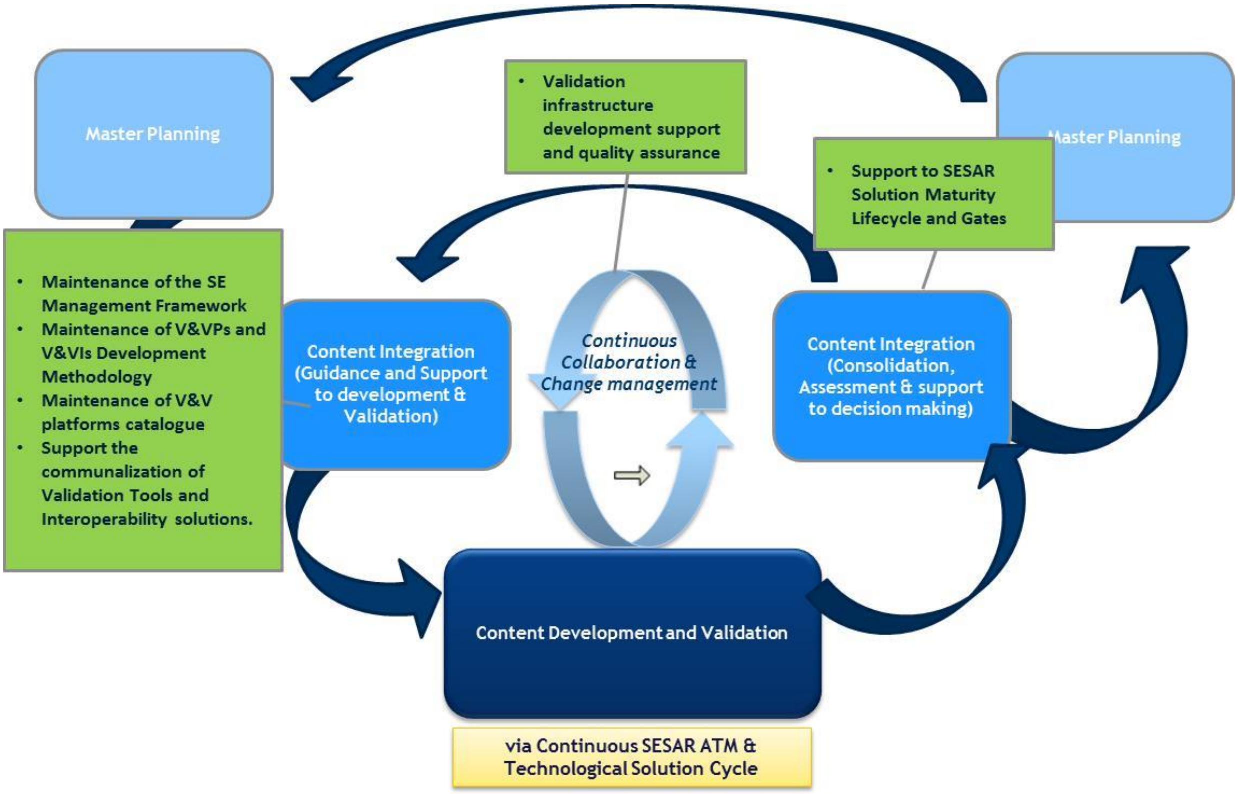
In addition, the granularity / level of detail of available evidences (SE data and deliverables) were not homogenous and not always sufficient to guarantee their usability and significance for the SESAR Community.

High level solution description

The project PJ22 will not target the industrial development of the V&VIs, V&VPs and demonstration platforms. In particular these developments are under the responsibility of each SESAR Solutions and VLSD project (e.g. the production of prototypes, industrial tools/mock-ups, integration into the V&VI, engineering artefacts, system integration for VLSD, etc.). PJ22 is only responsible for the specification (not the development) of long-term shared developments on the V&VIs, becoming an enabler for future exercises validation activities.

The opportunity for the SESAR 2020 Programme is to move forward, building harmonized V&VIs, V&VPs and demonstration platforms with common tools making effective use of valuable engineering resources applying standardized methods and tools in order to achieve comparable results of high quality across a range of infrastructures, obtaining a valuable asset for European Research & Development and Demonstration activities. SESAR 2020 activities will require adequate concept validation tools[1] e.g. traffic generation tools capable of modelling a target SESAR 2020 environment.

The activities performed by PJ22 are shown in green in the overall content development process shown in the figure and detailed below.



1) Maintenance of the SE Data Management Framework (SE-DMF)

This activity involves the following aspects:

- Development and maintenance of processes, methods and tools for SE data Management (e.g. requirements, validation objectives/results)
- Guidance for compliance with these principles to ensure consistency between all projects, in particular between the Content Integration and Content Development and Validation layers;
- The provision of training and coaching of these processes and tools;
- Design, implementation, maintenance and operation of SE data handling tools suitable to support SE Data Management thus:
- Providing visibility and transparency
- Improving access, awareness, coordination and data sharing
- Ensuring technical transversal consistency and traceability
- Definition of quantitative indicators (justified by well-defined needs) to measure the compliance of SESAR Solution and VLSD projects with the SE management framework (e.g. SMART requirements etc.).

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[1] 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.

SE Data Management shall be based on a Data centric approach. The goal is to allow capturing SE data in a structured way ensuring consistency, coherence and coverage analysis at Programme level.

Note that the definition and maintenance of the SE data model is under SJU responsibility. Related processes and tools will comply with the SE data model e.g. tools supporting SE Data Management must be suited to formally capturing content produced by projects in the different phases of their lifecycle (from requirements to validation results). This allows mapping the content of different deliverables, which is essential to show that requirements are justified and satisfied.

This activity shall support the other Content Integration processes and the Concept Development and Validation process.

SESAR Solution, Enabling and VLSD projects shall provide the required SE data through the processes and tools defined and maintained by PJ22 and shall comply with SESAR SE Data Management Framework.

The Member(s) contributing to the SE Data Management Framework will act as repository manager based on the developed SE tool. The SJU retain full rights and ownership on the content of the SE Data database. The Validation & Demonstration project through its contributing member(s) will provide a virtualised desktop environment providing suitably authorised and trained users remote access to the repository. The Validation & Demonstration project will have to maximise the overall effectiveness and value of the SE Data Management Framework activity by ensuring that it meets the needs across the Programme and for the SJU staff to undertake its responsibility.

When required and upon SJU request, the Validation & Demonstration project will deliver the elements allowing the SJU to continue the SE Data Management operations, in particular:

- The populated database;
- The set of tool configuration and customisation files.

The SE data Management Framework is a pre-requisite for the following two activities in PJ.22:

- **1.a) Validation and Demonstration Infrastructure Development Support and quality assurance:** Following the SESAR Validation Exercises life cycle, PJ22 will contribute to the quality assurance of the outputs of SESAR Solution and VLSD projects by:
  - Monitoring the correct application of V&VPs, V&VIs and Demonstration Platform Development Methodology;
  - Providing expertise and support to Solution and VLSDs Projects when developing V&VIs, V&VPs and demonstration platforms;
  - Defining and providing quantitative indicators (justified by well-defined needs) to measure the compliance with the afore mentioned methodology;
  - Performing a quality analysis of the availability note of V&VIs, V&VPs and demonstration platforms, made available before the execution of the validation/demonstration activity, and developed by Solution Projects and VLSDs. The availability note shall provide the links to the System Engineering Management Framework (SE-DMF) repository where the SE data produced during the development of V&VIs, V&VPs and demonstration platforms shall be captured.
    PJ22, under SESAR JU guidance, will perform ad-hoc “on the field” analysis to check the readiness of V&VIs, V&VPs and demonstration platforms for key validation/demonstration activities.

- **1.b) Support to SESAR Solution Maturity Lifecycle and Gates: In the context of the SESAR Solution Maturity Lifecycle, at a given Vx gate, PJ22 will contribute by:**
  - Providing, per SESAR solution, traceability matrixes between operational and technical requirements and the validation results produced by Solution, Enabling and VLSD Projects and coverage matrixes of associated elements of the Integrated roadmap (SESAR Solutions, OI steps and Enablers) e.g. between operational & performance requirements vs. technical requirements, between validation objectives/results vs. operational & performance requirements;
  - Assessing the evidences provided by Solution and VLSD projects to justify the fulfilment of maturity criteria related to validation;
  - Ensuring that any issue related to SE data e.g. technical requirements not traced to operational requirements, missing link to relevant OI step / enabler and the corresponding corrective actions are captured and monitored.
  - The support to Gates (e.g. traceability/coverage) will be performed based on query and report consolidating data captured through the System Engineering Management Framework (SE-DMF) repository.

    Note that the maturity assessment of a SESAR solution is under the scope of the Solution and VLSD projects that shall apply the SESAR maturity criteria and collect evidences supporting the achievement of the different maturity criteria. The results of the maturity assessment across the programme will be collected and consolidated by the SJU in the SESAR Maturity Report (out of the scope of PJ22).

2) Maintenance of the V&VPs, V&VIs and Demonstration Platform Development Methodology

It is under the scope of PJ22 to maintain and improve (if required e.g. following results from **EUROCAE WG-81 “Interoperability of ATM Validation Platforms”**) the V&VPs, V&VIs and Demonstration Platform Development methodologies (defined in SESAR 1) to be applied by the SESAR solution and VLSD projects. The methodology addresses the specification, development, verification and acceptance of platforms for V2 & V3 validation activities as well as for demonstration activities and shall be aligned to SESAR PMP. Tailored principles must be defined to adapt the methodologies to the maturity phase and to the complexity of Validation Exercises (number of partners involved, prototypes, IBPs involved) and thereby creating an agile process with minimized overhead).

SESAR solution and VLSD projects shall align to the agreed methodology and apply it in their activities.

This activity also includes the required training in order to ensure its correct application by the SESAR Solution and VLSD projects.

A separate set of V&V methodologies, platforms and tools, including model-based fast-time simulation techniques will be defined, maintained and applied by projects within the Exploratory Research for early validation and are therefore out of the scope of PJ22.

3) Maintenance of V&V platforms and Demonstration platforms catalogue

Maintain the catalogue of the existing V&V and Demonstration Platforms and associated documentation from SESAR 1 describing their current capabilities and their planned evolution. Every time a new platform is proposed by a SESAR Solution or VLSD project, PJ22 will be in charge of requesting the required information (platform capabilities and evolution plans) to include it within the catalogue.

This catalogue will be used:

- As a reference to identify the gap between the current capabilities of the V&V and demonstration platforms and the needs for supporting the required validation / demonstration activities;
- By the activity “Support the communalization of validation tools for the long-term” that should be based on the list of services that each platform is providing and identify candidates for their

communalization.

4) Support the communalization of validation tools and interoperability solutions

This activity supports the communalization of validation tools and interoperability solutions when found appropriate by:

- ○ Enabling the identification and selection of a set of strategic validation tools and interoperability solutions that could improve the SESAR 2020 validation process (supporting several partners and/or several projects validation needs and thus improving cost-efficiency);
- ○ Producing technical specifications, interoperability requirements and conformance criteria that are applicable for the different simulators, tools and V&VIs, following PJ19 guidelines, methodologies and high-level architecture (e.g. ADD/TAD-like). **The development of any tool is out of the scope of PJ22**;
- ○ Providing guidance and support to SESAR Solution and VLSD projects in particular respect to the Validation exercises that require multiple IBPs and for the necessary industrial development/customizations which could be necessary for the V&VP configuration. **The development of any tool is out of the scope of PJ22**.

While the focus in Wave 1 shall be the identification of those V&VI solutions that complying with specific services and capabilities (e.g. IOP...) could be used as a common tool in Wave 2, the focus shall be on the definition of common specifications that different solutions should comply with, so contributing to harmonised V&V platforms and infrastructures.

However, even in Wave 1 and on top of the existing standards i.e. EUROCAE WG-81 “Interoperability of ATM Validation Platforms”, and if well justified by the needs identified by SESAR Solution & demonstration projects, this activity could as well produce technical specifications, interoperability requirements and conformance criteria for communalised V&VIs required for achieving Wave 1 objectives.

The industrial development of the V&VIs, V&VPs and demonstration platforms is under the responsibility of each SESAR Solution and VLSD project and therefore they are responsible for implementing the technical specifications/interoperability requirements and comply with the conformance criteria identified by PJ.22.

PJ22 will be responsible for coordinating the contribution to the EUROCAE WG-81 “Interoperability of ATM Validation Platforms”.

Dependencies with other projects or external activities if required

- ATM Solution and Enabling Projects
- Content integration Project

Final deliverables

- V&VPs, V&VIs and Demonstration Platform Development Methodology Training Plan
- SE Management Framework
  - ○ Licences
  - ○ SE Tooling Development Plan (customisation of the selected tool application)
  - ○ SE – DMF Training Plan
  - ○ SE – DMF Quality and Status Report
- V&V platforms and Demonstration Platform catalogue (yearly)

- List of candidate communalized Validation Tools and Interoperability solutions
- Technical specifications for communalized Validation Tools and Interoperability solutions
- V&I, V&P and Demonstration Platform Quality Report
- Traceability and coverage SE data reports for gates

B.3 Master Plan Maintenance (PJ20)

PJ.20	Master Plan Maintenance

Problem Statement

In application of Article 3(1) of Regulation (EU) No 409/2013, The ATM-Master Plan (ATM-MP) has been given the status of being "*the roadmap driving the modernisation of the European ATM system and connecting SESAR research and development with deployment. It shall be the key SES instrument for the seamless operation of the EATMN and the timely, coordinated and synchronised SESAR deployment*".

The ATM-MP has three levels (Executive, Planning and Implementation) that require synchronised monitoring and alignment. The work shall consist in maintaining, updating and publishing as and when necessary the ATM-MP. It shall also consist in managing the ATM-MP update campaigns. Such campaigns consist in a major and simultaneous update of the three levels of the ATM-MP.

The related challenges that have to be addressed by the project:

  - The Single European Sky objectives may not be achieved if SESAR solutions are not developed and implemented in a performance-orientated manner. Without an adequately updated ATM-MP, SESAR may fail to look at performance issues and to re-focus the SESAR work programme on emerging needs.
  - Ensuring seamless transition from R&I results (SESAR Releases) to deployment activities;
  - Addressing key issues related to the Architecture at MP level;
  - Achieving consistency between the three levels of the MP;
  - Maximising levels of complementarity between the MP, Common Projects and the Deployment Programme which will be maintained by the Deployment Manager ("project view") for those MP elements that will be deployed via "Common Projects";
- Providing sufficient stakeholder commitment to the process and results.

High level solution description

The ATM-MP maintenance process covers the definition of the content, the priorities and the high-level development and deployment plans of the new Air Traffic Management (ATM) system contributing to the achievement of the Single European Sky (SES). It defines the essential operational changes that need to occur in order to achieve the SES objectives and also identifies the related functionalities that operational stakeholders will have to implement at a given time and place. It provides the basis for the timely, coordinated and efficient deployment of new technologies and procedures, whilst ensuring alignment with International Civil Aviation Organisation (ICAO) standards for global interoperability and synchronisation.

In particular significant updates of the ATM-MP shall undergo a transparent and collaborative process all the way to the formal consultation phase in order to secure a broad consensus on the content and the level of ambition of the next versions, agree on where there is a need to act, articulate a clear vision and set the right priorities.

The SJU and its Governance Bodies are fully in charge of all phases of the master plan maintenance, from developing the updated version, involving stakeholders, launching various expert consultations, taking on board comments, helping diverging opinions converge, etc … to approving the final document.

The Member(s) contributing to the maintenance of the Master Plan will act as repository manager based on the Master Plan Portal. The SJU retain full rights and ownership on the content of the Master Plan database (Public and Working Area Portal). The Master Plan Maintenance project through its contributing member(s) will provide a virtualised desktop environment providing suitably authorised and trained users remote access to the repository. The Master Plan Maintenance project will have to maximise the overall effectiveness and value of the Master Plan maintenance activity by ensuring that it meets the needs across the Programme and for the SJU staff to undertake its responsibility.

When required and upon SJU request, the Master Plan Maintenance project will deliver the elements allowing the SJU to continue the maintenance of the Master Plan operations, in particular:

- The populated database;
- The set of tool configuration and customisation files.

The main scope of the Master Plan Maintenance project is therefore to support the delivery of up-to-date maintenance of the ATM MP and the alignment of its three levels. This includes ensuring that the SESAR performance ambition level is correctly established at the highest level and can flow into the programme to drive R&I and deployment prioritisation. Within the Programme, this implies in particular a close collaboration with the Content Integration project.

To that end, the project shall be in charge of organising the work supporting delivery for the following activities in support and under the leadership of the SJU and its governance bodies:

1. Master Plan: The three levels of the ATM-MP consisting in: The Executive View (Level 1), the Planning View (Level 2) and the Implementation View (Level 3).

   The activities and processes shall be:

   - To support the management of the Master Plan campaign and publish the adopted ATM-MP Editions (synchronisation of the three levels). One ATM Master Plan update campaign is expected to be conducted before 2020.
   - Starting from the SESAR Solutions, to outline the essential and other operational and technological changes that will enable SESAR to contribute to achieving the SES high-level goals.
   - To manage the ATM-MP portal that, in addition to providing access to the 3 levels of the ATM-MP, also provides access to the architecture (EATMA), the Integrated Roadmap, the lexicon and the standardisation and regulatory roadmaps.

2. Deployment packaging and scenario development incl. incentives (ATM MP Level 2):

   The activities and processes shall be:

   - To identify which SESAR Solutions 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 Analysis information.
   - To detail the operational and technological changes resulting from R&I activities, the investors concerned, the deployment timeframe and the geographical scope where the changes will impact and deliver benefits. To consider incentives principles, regulations and standards needed to secure their deployment.
   - To develop proposals for operational and financial incentivisation principles for mitigating deployment risks. These principles can be generic or specific, depending on the nature of

the deployment to be encouraged.

- Baseline and publish the related “Data Sets” (containing OIs, ENs, IOC, FOC, targeted operating environments and associated deployment scenarios for SESAR Solutions or clusters of SESAR solutions when justified from a deployment logic perspective) in close cooperation with the Content Integration project and following decision made through the change management process.

3. Performance Planning:

Performance planning addresses performance ambition levels for the medium to long term time horizon. It describes the performance capability level that should be enabled by SESAR at certain points in time. It is linked to an analysis of the performance baseline and a forecast per operational environments and geographical areas per intermediate years. The performance ambition level expressed in the ATM Master Plan should be consistent and complementary to the work performed within the performance pillar of the SES.

4. Implementation Planning and Monitoring (ATM MP Level 3):

Implementation Planning translates relevant Level 2 information of the ATM MP into an implementation view (Level 3).

The designation by the European Commission of the Deployment Manager, with its own reporting obligations, will bring the SJU to re-assess the current set up for the maintenance activities at 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 perspective.

The SJU will consider the issue bearing in mind the following key principles:

- Operational stakeholders investing in deployment should play a leading role in managing and implementing deployment activities, while avoiding any conflict of interest (Regulation (EU) No 409/2013, Recital 14);
- The Commission should oversee deployment activities making sure they follow the SES objectives and safeguard the public interest, by establishing appropriate reporting and monitoring mechanisms making the best use of existing instruments such as the European and Local Single Sky Implementation (ESSIP Plan and Report and LSSIP documents) (Regulation (EU) No 409/2013, Recital 16);
- The Deployment Manager has the responsibility of monitoring and reporting to the Commission on the implementation of the deployment programme (Regulation (EU) No 409/2013,Article 9 (h) and (i)).
- The PC Tiger Team recommendations include putting in place “the necessary arrangements to handle a possible transition process for SESAR Deployment reporting mechanisms (ESSIP/LSSIP vs. SESAR Deployment reporting through the Deployment Manager). This possible transition should be sound and effective”.
- Double reporting should be avoided; simplicity and reliability of reporting should be sought.

On this basis a specific deliverable shall be developed and issued to support further decision-making and alignment of the ATM MP maintenance, monitoring and reporting processes.

Furthermore, the need for the SJU to monitor the deployment baseline makes it important for it to have early access to the annual reports on capital expenditure prepared by the PRB in application of Article 3 (3) (i) of the performance Regulation (EU) No 390/2013. Discussions are ongoing with the PRB to determine whether and to what extent the SJU could play a more active role in the preparation of these reports, e.g. through expressing its specific needs or contributing to the preparation of the reporting templates.

5. Support for definition of Common Projects:

Subject to a mandate being given to the SJU to support the EC for these types of tasks, the task shall be to provide expert level input that will define the building blocks supporting the definition of future Common Projects.

6. Regulation:

The activities and processes shall be:

- To identify the links with existing regulation and potential needs for new regulatory actions.
- To maintain the regulatory roadmap for the part related to SESAR.

7. Standardisation:

The activities and processes shall be:

- To assess standardisation needs and timelines.
- To maintain the standardisation roadmap for the part related to SESAR.

8. Business Cases

The activities and processes shall be:

- To demonstrate a positive Business Case while identifying specific negative Business Case situations. This work should leverage consolidated performance results stemming from the Content Integration project.

Dependencies with other Projects or external activities if required

There is particularly strong dependency with the Content Integration project in the sense that the Planning View will be maintained through a collaborative process including Content Integration and Master Plan projects in line with Change Management as defined in the execution Guidance and to be further refined before the start of the projects .

Final deliverables

- One major update of the synchronization (and update of all 3 levels) is foreseen before 2020
- Yearly ATM-MP Level 2 plan and report
- Yearly ATM-MP Level 3 plan and report
- Yearly Update to Standardisation and Regulation Roadmaps
- Enhanced ATM-MP Level 3 maintenance, monitoring and reporting process description
- Business Cases to support any new implementation objective related to Level 3 of the ATM-MP (yearly)
- Support to the definition of Common Projects (ad-hoc)

Appendix C SESAR2020 Project Descriptions - Wave 1 of Industrial Research Transversal Activities

C.1 High Performing Airport Operations – Increased Runway and Airport Throughput (PJ02)

PJ.02	Increased Runway and Airport 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. This situation becomes more critical when the weather situation is adverse. Airports are additionally constrained by different limitations (European, National and local) aiming at minimizing the noise impact on citizens living around airports. Therefore, there is pressure to improve the efficiency of runway operations. The main related improvement areas are listed here:

- SESAR 1 will deliver RECAT 2 Static Pair-Wise Separation (S-PWS) for arrivals at V2 maturity, and RECAT 3 Dynamic Pair-Wise Separation (D-PWS) for arrivals at V1 maturity. There is a need to continue R&D activities to further mature both concepts, which are expected to provide benefits in both a simpler distance-based version and a more advanced time-based version. Reduction in wake-vortex separation minima for departures remains to be addressed. Development of adequate system support for this concept is necessary in order to make these concepts fully usable.
- Current static ICAO Wake Vortex separation minima are generic (i.e. the same for all airports). Wake vortex separation minima could be tailored for each airport taking into account their fleet-mix.
- Use of differentiated glide paths, displaced thresholds and adaptive runway aiming points based on GBAS has been researched in SESAR 1. They allow for reduced separation between aircraft on final while still ensuring wake vortex encounters are avoided. Maturity at the end of SESAR 1 is expected to be V2/initial V3. R&D in SESAR 2020 should be the GBAS-based concept to full maturity, as well as research a similar solution based on SBAS.
- When reduced wake-vortex or time-based separation minima are applied, Minimum Radar Separation (MRS) on final approach may become the constraining factor. In order to realise full benefits of reduced wake-vortex and time-based separation minima it is necessary to reduce MRS. SESAR 1 will deliver V2 maturity on 2NM MRS. Significant technical and operational validation is required in order to fully mature and integrate the concept.
- Runway Occupancy Time (ROT) is a constraining factor for runway throughput in mixed mode operations.
- In mixed mode operations, integrated arrival and departure management (AMAN/DMAN) will need to take into account the new distance or time-based wake-vortex separation minima and MRS where available, and integrate it with ROT prediction in order to organise runway demand to get maximum runway throughput.
- SESAR 1 has delivered V3 maturity of GBAS GAST D and RNP transition to xls. Further work is needed to obtain full GNSS benefits in Terminal Areas (TMA), i.e. Enhanced TMA operations based on the use of efficient curved routes. R&D should also look into ensuring the availability

of GBAS by developing Multi Constellation/Multi Frequency (MC/MF) solutions.

- SESAR 1 has delivered Time Based Separation for headwind resilience to V3 maturity as a first step to increase resilience of operations in challenging weather conditions. Weather Dependent Separation (WDS) for arrivals facilitating reduced wake separations in cross-wind conditions is expected to achieve V2/ initial V3 maturity in SESAR 1. Full integration with ROT, wake, TBS and system support will require further validation.
- Optimisation of runway management to detect imbalances between Demand and Capacity due to weather or other constraints will lead to improving the resilience of operations. SESAR 1 has not considered the optimisation of runway throughout around reduced visibility conditions and, more specifically, the planning of operations (flow rates, MRS, ROT, TBS etc.) based on the onset/cessation of such events. R&D in SESAR 2020 should also look into the improvement of the way MET information is used in planning, and explore the use of event probabilities and impact analysis to optimise procedures around adverse weather.
- In good weather conditions, rotorcraft operations are generally not an issue, because dedicated VFR approaches to the airport runway or Final Approach & Take-off (FATO) often enable independent aircraft and rotorcraft operations. In Instrument Meteorological Conditions (IMC), ICAO criteria for IFR FATO (Annex 14) must be used. These are very demanding in terms of protection areas, lighting and operating constraints, which limit their use. As a consequence, IFR Rotorcrafts are currently constrained to use same approach/departure procedures as fixed wing aircraft at busy airports. SESAR 2020 R&D should look into how to overcome such limitations.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

The overall strategy of enabling enhanced runway throughput is to improve the efficiency and resilience of arrival and departure operations through the following solutions:

SESAR Solution PJ.02-01: Wake Turbulence Separation Optimisation

Regarding the consideration of Wake Vortex for separation minima, an incremental approach is expected to be established through the implementation of the steps described below. The application of reduced separations resulting from the Solution PJ.02-01 but also from Solutions PJ.02-03, and PJ.02-09 will require the use of the a final approach delivery tool allowing the ATCO to deal with these various runway throughput enhancement concepts. That tool is called Optimised Runway Delivery (ORD) tool and will be further developed as part of this solution.

- S-PWS: Potential further enhancements of RECAT-EU wake separations through the definition and validation of an S-PWS matrix in both distance and time and for both arrivals and departures, fully integrated with ORD support. A simpler matrix may be derived for each airport based on category groupings that take into account the local fleet mix and capacity needs, which may need to be adapted to changing demand over time. This may allow S-PWS benefits to be realised without the need of an ORD tool.
- D-PWS: Downlinked information from aircraft for optimising runway delivery may also be used in order to predict wake vortex and determine appropriate wake-vortex minima dynamically;
- Weather Dependent Reduced Wake Turbulence Separations: Full application of weather dependent separation (WDS) for both departures, over the initial departure path, and arrivals,

over the final approach path, taking into account the impact of meteorological conditions (e.g. crosswind, headwind, turbulence, and temperature) the resulting wake vortex behaviour and corresponding severity assessment. Integration with other supporting functionalities, RECAT EU / new RECAT / Optimised Categories, A-PWS and D-PWS should be studied;

- Development of wake risk monitoring and awareness function (ground and airborne);
- Development of wake vortex decay enhancing devices on the airport surface in order in order to increase safety, as well as potentially enable further capacity gains.

This DoW assumes that arrival aspects of AO-0306 “Wake Turbulence Separations based on Static Aircraft Characteristics” and AO-0310 “Weather-dependent reductions of Wake Turbulence separations for final approach” will be V2 at the end of SESAR 1. The A0-0304 “Weather-dependent reductions of Wake Turbulence separations for departure” is V2 on the basis of the CREDOS project.

SESAR Solution PJ.02-02: Enhanced arrival procedures

Mitigation of noise and adaptation of wake avoidance procedures through concepts such as multiple runway aiming points and glide slope increase which move noise into the centre of the airport and take account of wake transport. In some runway configuration scenarios, this may provide additional benefits to the 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, RECAT and solutions related to ROT optimisation.

SESAR Solution PJ.02-03: Minimum Pair Separations based on RSP

Reduction of separation minima is strictly dependent on the availability of accurate aircraft position data, which is related to the Required Surveillance Performance (RSP) concept. RSP could allow for the application pair-wise separation down to a minimum of 2NM for arrivals on final approach. To this end, there is a need to investigate the surveillance technology (e.g. Primary and Secondary Surveillance Radar, GNSS/GBAS, WAM) which have the potential to meet the RSP requirements.

SESAR Solution PJ.02-05: Independent Rotorcraft operations at the airport

This solution will develop rotorcraft-specific approach procedures. Development of Satellite Based Augmentation Systems (SBAS)-based Point-in Space (PinS) Approaches into VFR FATOs in airports will remove IFR rotorcraft from active runways and allow fixed wing aircraft and rotorcraft Simultaneous Non-Interfering (SNI) approaches, which will have a positive impact on runway throughput. Rotorcraft-specific Approach Procedures with Vertical Guidance (APV) and PinS approach procedures will improve access into secondary airports in LVC.

SESAR Solution PJ.02-06: Improved access into secondary airports in LVC

This solution will improve access into secondary (small/medium) airports in low visibility conditions through the development of an affordable surveillance solution (e.g. Remote Tower and additional camera-based systems). New airborne capabilities such as RNP and SBAS-based approach procedures will enable access to any airport in LVC without the need of ground equipment. MC/MF SBAS will allow approaches down to CAT II minima. Combined Vision Systems will enable pilots to safely land and vacate the runway down to 0 Runway visual Range.

SESAR Solution PJ.02-08: Traffic optimisation on single and multiple runway airports

The solution aims at providing ATC with integrated dynamic assistance tool to improve single and multiple runway airport operations by increasing predictability of runway capacity, optimizing runway configuration and optimizing arrival and/or departure spacing. This solution will integrate reduced wake and weather-dependent separation minima when applicable, as well as ROT information when available.

PJ.02-08 will develop a solution as integration of multiple concepts operating in both Execution and Planning Phases (Short and Medium term) that is able to support both Tower controllers and

Tower Supervisors in monitoring and optimizing runway system usage. For capacity constrained airports, this will be achieved by dynamically adapting the runway configuration to traffic demand while taking into consideration internal and external operational constraints, including airport performance indicators. Enhanced Coupled AMAN-DMAN systems will support controllers to sequence arrivals and departures according to the runway use plan.

SESAR Solution PJ.02-09: Enhanced Runway Conditions Awareness

Improvement of safety and situational awareness through the prediction of degradation of runway conditions taking into account different cues, like weather conditions, runway usage and any other additional factors that may be found to be significant. This will be combined with statistical data in order to improve the quality of ROT prediction, which will enable that the use of the runway is optimised. ROT prediction will be fed to AMAN/DMAN and Surface Management tools. Final approach CWP may also display information based on ROT.

SESAR Solution PJ.02-11: Enhanced Terminal Area for efficient curved operations

Using geometric vertical navigation guidance in the TMA will simplify operations by removing the workload associated to barometric to geometric vertical navigation transition. This will improve the efficiency and predictability of individual operations. In addition, it is expected to improve safety by reducing the rate of missed approaches. GBAS and SBAS capabilities in the terminal area will allow for increased flexibility in airspace design.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.02-01: Wake Turbulence Separations Optimization

Context about previous achievement in the domain:

This solution further extends the operational improvement achieved and demonstrated in the SESAR-1 Project 06.08.01.

Time-Based Separation (TBS) for Arrivals solution as validated in SESAR-1, and RECAT-EU solution based on SESAR-1 know-how are currently in deployment phase (respectively in London Heathrow and Paris CDG with entry into service planned for 2015). Both operational deployments are supported by regulatory decision respectively following EC regulation 716/2014 and EASA States recommendation.

The following quantitative benefits have been determined:

- Strong headwinds is the single biggest cause of delay at London Heathrow, affecting significantly traffic around 65 days each year (source: NATS).TBS allows a minimum of 50% delay reduction due to headwind at various EU airport hubs (source: EUROCONTROL)
- RECAT-EU brings runway capacity benefits of 5% or more against ICAO separations during peak periods depending on individual airport configuration, by reducing spacing between aircraft pairs. Gain in capacity could grow up to 8% in a five years' time horizon due to the evolution of the traffic mix.
- All airports can benefit from RECAT-EU, especially those with significant (at least 7% in a peak) "heavy" category traffic (fast time simulation conducted by the French Service Technique de l'Aviation Civile STAC with CAST: Comprehensive Airport Simulation Technology).

Solution Description:

S-PWS will deliver further enhancements of RECAT-EU wake separations through the definition and validation of an S-PWS matrix in both distance and time and for both arrivals and departures, fully integrated with ORD support. A simpler matrix may be derived for each airport based on category groupings that take into account the local fleet mix and capacity needs, which may need to be adapted to changing demand over time. This may allow S-PWS benefits to be realised without the need of an ORD tool.

D-PWS will use downlinked information from aircraft for optimising runway delivery in order to predict wake vortex and determine appropriate wake-vortex minima dynamically.

Weather-Dependent Reduced Wake Turbulence Separations will look into weather-dependent separation (WDS) minima for both departures, over the initial departure path, and arrivals, over the final approach path, taking into account the impact of meteorological conditions (e.g. crosswind, headwind, turbulence, and temperature) the resulting wake vortex behaviour and corresponding severity assessment. At the end of SESAR 1, S-PWS and WDS will be V2, and time-based separations will be V3.

The simultaneous deployment of these individual concepts, combined with Solution PJ.02-02 (Enhanced arrival procedures: glide path increase, displaced threshold and/or multiple runway aiming points), Solution PJ.02-03 (Reduction of MRS) and PJ.02-09 (Optimisation and prediction of ROT) will need further development and validation of "Optimised Runway Delivery" (ORD) tool to support controllers. The ORD tool will be based on the one developed for TBS in SESAR 1, and its purpose is to support controllers in providing variable pair-specific optimum separation. The capability of the ORD SESAR 1 tool to support varying separation as a function of headwind (for TBS) will be extended to support the delivery of the separation resulting from the combination of the concepts described above, which correspond to the new OI (**AO-0328**).

A departure version of the ORD tool will be designed for supporting the departure runway controller in providing optimum separation. The departure ORD will consider additional parameters like expected rolling distance, climb angle and Standard Instrument Departure (SID) (**AO-0329**).

A simpler separation matrix based on S-PWS may be derived for each airport based on category groupings that take into account the local fleet mix and capacity needs, which may need to be adapted to changing demand over time. This simpler matrix may allow S-PWS benefits to be realised without the need of an ORD tool.

Ground based wake-decay enhancement devices and on board wake-risk monitoring function will also be developed for increasing efficiency and safety of time based RECAT-2, and WDS.

Solution PJ.02-01 is therefore a key enabler of not only simultaneous deployment of SESAR-1 wake concepts but also of the Solutions PJ.02-02, PJ.02-03, andPJ.02-09 of SESAR 2020.

In addition the ORD tool (**AO-0328**), even if only used for better delivery of current ICAO standard separations, has been shown to increase runway throughput in challenging wind conditions (e.g., tailwind at altitude with headwind at the ground level). The ORD tool alone increases ATCO efficiency by facilitating the management of the excessive distance spacing compression experienced on final approach in such challenging conditions. This enables an increase in runway throughput by facilitating a reduction of the additional spacing buffer usually employed in these difficult conditions when no support tool is available.

Eventually, the Solution PJ.02-01 will allow for coordinating at European level the separation standard to be proposed and further consolidated at ICAO level. This will ensure that the global concept delivers acceptable benefits for the European traffic mix and meets European safety standards.

<u>Performance Goals:</u>

The SESAR-2 individual solutions integrated with time based (before but not combined with each other) and their quantified effect are described below:

<u>TBS pair- wise separation (RECAT-2 + TBS) - AO-0306 + AO-0303 _</u>

The expected impact on capacity, Operational Efficiency and Resilience has been produced using the methodology jointly developed by STAC and EUROCONTROL[2].

<u>Capacity</u>:

Expected runway throughput increase by 5 to 10% on both arrival and on departure (depending on traffic mix) during peak periods, at constrained airports

This can be quantified in term of additional movement per airport in peak hour in comparison to application of current ICAO separations if TMA (dependency with PJ-01) and ROT (dependencies with

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[2] DGAC/STAC: Expertise d'évaluation des gains en capacité du projet RECAT-EU – Ref. 14_0506_D_REXP_STAC_ACE_CS

Solutions 7 and 9) don’t become the bottle necks for example:

- 9 additional arrival movements per day in EHAM
- 15 additional arrival movements per day in LFPG
- 20 additional arrival movements per day in EGLL (10 in the morning peak)
- 24 additional arrival movements per day in LTBA
- 30 additional arrival movements per day in EDDF

Over the next 20 years, many additional EU airports will become capacity-constrained as predicted by the ‘**Challenge of Growth**” study (source: EUROCONTROL) and will benefit from the previous solution.

The reduction of wake turbulence separation on departure will allow an overall increase in runway capacity and avoid congestion from the increase in the arrival traffic flow.

Operational Efficiency and Resilience:

Reduction of airborne delays due to arrival capacity limitations linked to wake separations

For the major airport that are today constrained in peak hours, the use of optimised wake category scheme or pairwise separations can either be translated into added capacity (as described above) or additional resilience in case of perturbation.

This has been independently quantified by the French STAC (Service Technique de l’Aviation Civile) for CDG using 6 categories scheme for a test case: LVP condition imposed during the morning peak.

20% reduction of recovery time (time to come-back to nominal planning)

12% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)

For the major airport that are today capacity constrained in peak hours, the use of time based separation will enable a reduction of a minimum of 50% of delay induced by headwind, which is a major source of European network delay (P681 VALR).

On less constrained airports, significant improvement can also be observed by employing reduced separation applied on a time based separation basis in the specific runway configuration or wind conditions responsible for a large part of the airport delay.

Increase in the flexibility for Controllers to manage the arrival traffic due to the separation minima reduction.

Reduced TBS as function of weather conditions (WDS + TBS) – AO-0310 and AO-0304 and AO-0303

The application of weather dependent separations (WDS) through a reduction or a suspension of the time based wake turbulence separations, over the duration of identified and stable forecast weather conditions, that either ensures transport of the wake turbulence out of the path of the follower aircraft, or ensures decay of the wake turbulence so that it is no longer a hazard to the follower aircraft for:

departures from the runway for the initial common departure path,

arrivals on final approach,

Taking into account any meteorological conditions (e.g. crosswind), integrated with system support for separation delivery, RECAT EU / RECAT 2 / Optimised Categories and TBS.

Development of advanced departure procedures based on wind conditions will allow the follower departure aircraft to avoid the wake generated by the departure aircraft in front on the same runway by employing an earlier rotation position and a steeper initial climb path.

The objective is to enable a tactical increase in the arrival and departure achieved capacity in favourable weather conditions so as to more efficiently deal with the fluctuations in the arrival and departure demand with a positive effect on runway queuing related delays.

Capacity:

Expected runway throughput increase as a function of traffic mix and weather conditions.

The increase of arrival capacity will be directly proportional to the proportion of wake constrained pair in the peak hours. In case of favourable crosswind conditions the expected benefit can be quantified as followed (A380 not considered):

An increase of 5% runway throughput for 10% Heavy* in the traffic mix

An increase of 10% runway throughput for 20% Heavy* in the traffic mix

An increase of 20% runway throughput for 50% Heavy* in the traffic mix

An increase of 30% runway throughput for 80% Heavy* in the traffic mix

With 10% A380 in the traffic mix

An increase of 10% runway throughput for 10% Heavy* in the traffic mix

An increase of 20% runway throughput for 30% Heavy* in the traffic mix

An increase of 30% runway throughput for 60% Heavy* in the traffic mix

*Heavy wake category aircraft

Operational Efficiency:

The increase throughput being dependent on the observed weather conditions, the actual increase of airport capacity will depend on the frequency favourable conditions are observed, and hence why the substantial runway throughput described above should be predominantly used for reabsorbing delay. It is important to note that this solution is in addition to the concepts permanently applied like TBS or PWS. EUROBEN study has however shown that the condition for using reduced separation thanks to crosswind can be very frequent at some airports. The weather dependant reduction of wake separation, considering the allowable increase of throughput, is expected to be a major mitigation of delay and to provide for an increase in the flexibility for Controllers to manage the arrival traffic due to the reduction in the required wake separations.

Using similar approach as the one developed by the French STAC (Service Technique de l'Aviation Civile) for CDG, the use of weather dependant reduction for a test case: LVP condition imposed during the morning peak has shown a reduction.

- 30% reduction of recovery time (time to come-back to nominal planning)
- 20% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)

Decay enhancement devices as safety improvement and/or booster of WDS / RECAT-2 effect – AO-0325

The installation of decay enhancing devices at the runway tails, so-called plate lines, in order to accelerate wake vortex decay in ground proximity, i.e. the flight phase with most reported encounters. These devices shall increase flight safety and capacity gains to be achieved by the RECAT-EU/RECAT-2 matrix and weather dependent separations (WDS). For this purpose the compatibility with airport requirements and the technical realisation shall be elaborated. Comprehensive validation at a suitable major airport (e.g. with Lidar and/or 3D Radar). It would lead to further optimisation of RECAT-EU/RECAT-2 matrix and WDS considering the beneficial effects of the decay enhancing devices.

Safety:

Reduction of the maximum WV life time by 20% leading to a positive impact on wake encounter rate close to ground and hence creating an associated safety benefit.

<u>Wake monitoring as safety improvement– AO-0327</u>

Ground based or airborne wake turbulence prediction/detection will improve operation safety by providing with better awareness of wake turbulence risk. The airborne function could also be useful in other flight phases (en-route for example).

This monitoring could also be alternative options (complementing regular reporting scheme) to provide with efficient and objective inputs for wake vortex encounter risk monitoring as recommended by EC Regulation No 1035/2011 “Common Requirements”, Annex II and technically specified in RECAT-EU safety case report. Wake Turbulence risk monitoring activity shall be conducted at places where RECAT scheme will be deployed and applied in operation (reporting, ground or airborne monitoring).

Need for coordination:

The solution doesn’t require a synchronised deployment with multiple stakeholders. Strictly speaking, it doesn’t require for being operated EU-wide multi-stakeholders standard neither since the solution will be primary local solution. However, development of a common EU standard or Specification with the safety evidence and generic safety case to support the local safety case may really facilitate these local deployments.

The glideslope wind conditions profile can be derived from the already mandated Enhanced Mode S airborne parameters from the arrival aircraft flying the final approach glideslope. The use of broadcasted MET information (as used for TBS at Heathrow) but also possibly (even if not currently mandated) of downlinked landing stabilisation speed intent by equipped aircraft may need interoperability and equipment to be deployed; however this will just be considered as one of the option for Solution PJ.02-01 that can also be used if available. This means that the Solution PJ.02-01 remain a local solution.

Operating Environment:

Capacity constrained airports or airports with observed delay.

Reduced wake separations and associated increase of runway throughput will benefit to all airspace users that are constrained by runway capacity during peak hours when wake separations are frequently applied.

List of OI steps and enablers:

SOLUTION PJ.02-01 Wake turbulence separation optimization	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AO-0328 "Optimised Runway Delivery on Final Approach"	V2			V3	

Enabler Code	**Enabler Title**
A/C-47	Onboard management of meteorological data from onboard sensor for sharing and use by MET service providers
AERODROME-ATC-17	Airport ATC tool to Support Time-Based Separation in Final Approach
AERODROME-ATC-68	ATC system to support optimised runway delivery on final approach
APP ATC 120	ATC system to support optimised runway delivery on final approach
APP ATC 156	ATC System to Support Time-Based Separation in Final Approach
APP ATC 99	ATC System to use Real-Time Meteo Information Received From Met Systems
METEO-03	Provision and monitoring of real-time airport weather information, Step 1
METEO-04b	Generate and provide MET information services relevant for Airport and final approach related operations, Step 1
SWIM-APS-07a	Stakeholder systems consumption of Meteorological Information services for Step 1

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AO-0329 "Optimised Separation Delivery for Departure"

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<tr><td>A/C-47</td><td>Onboard management of meteorological data from onboard sensor for sharing and use by MET service providers</td></tr>
<tr><td>AERODROME-ATC-69</td><td>ATC system to support optimised departure separation</td></tr>
<tr><td>METEO-03</td><td>Provision and monitoring of real-time airport weather information, Step 1</td></tr>
<tr><td>METEO-04b</td><td>Generate and provide MET information services relevant for Airport and final approach related operations, Step 1</td></tr>
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<tr><td>SWIM-APS-07a</td><td>Stakeholder systems consumption of Meteorological Information services for Step 1</td></tr>
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AO-0310 – “Weather-dependent reductions of Wake Turbulence separations for final approach”
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<tr><td>AERODROME-ATC-60</td><td>Airport ATC system to monitor wake turbulence risk using ground-based LIDAR/Radar</td></tr>
<tr><td>AIRPORT-08</td><td>Decay Enhancing Devices</td></tr>
<tr><td>APP ATC 74</td><td>ATC System Support for Reduced, Weather-Dependent Separation Standards in Final Approach</td></tr>
<tr><td>APP ATC 99</td><td>ATC System to use Real-Time Meteo Information Received From Met Systems</td></tr>
<tr><td>METEO-03</td><td>Provision and monitoring of real-time airport weather information, Step 1</td></tr>
<tr><td>METEO-04b</td><td>Generate and provide MET information services relevant for Airport and final approach related operations, Step 1</td></tr>
<tr><td>METEO-05b</td><td>Generate and provide MET information relevant for TMA and En-route related operations, Step 1</td></tr>
<tr><td>SWIM-APS-07a</td><td>Stakeholder systems consumption of Meteorological Information services for Step 1</td></tr>
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<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>AERODROME-ATC-19</td><td>Runway Usage Management sub-system capable of processing initial departure path wind conditions information</td></tr>
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<tr><td>APP ATC 99</td><td>ATC System to use Real-Time Meteo Information Received From Met Systems</td></tr>
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<tr><td>APP ATC 118</td><td>ATC System to Support Pairwise Separation in Specific Conditions - Step 1</td></tr>
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AO-0323 – "Wake Turbulence Separations (for departure) based on Static Aircraft Characteristics"

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<tr><td>AERODROME-ATC-60</td><td>Airport ATC system to monitor wake turbulence risk using ground-based LIDAR/Radar</td></tr>
<tr><td>STD-046</td><td>Update ICAO DOC 4444 (PANS-ATM) for RECAT-2</td></tr>
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AO-0325 – "Reduction of Wake Turbulence Risk considering Acceleration of Wake Vortex Decay in Ground Proximity"

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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-08</td><td>Decay Enhancing Devices</td></tr>
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AO-0327 "Reduction of Wake Turbulence Risk considering Wake Monitoring and Awareness"

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<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
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Identification of CNS related needs

- Air and ground surveillance; D-Link; ADS-B.
- CTE-C02g Air to Air functionality of New A/G radios supporting AUO-0505 “Improved Air safety using data exchange via e.g. ADS-B for Wake Turbulence prediction”.

Identification of MET/AIM related needs

- MET needs; Meteorological (MET) information conditions a number of key elements in the envisaged optimisation of Wake Turbulence Separation. The MET information (integration) needs to support the Runway Usage Management sub-system capable of processing the ATC System to Support Pairwise Separation in Specific Conditions - Wave 1 and the ATC System Support for Reduced Weather-Dependent Separation Standards in Final Approach and Initial Departure path will be identified. This will include MET system considerations (broadcasting of airborne MET data - optional) and ground sensors (Lidar & Radar) to provide real-time spot information and defining the data and quality of service needs Very high resolution wind information, both on the ground and at altitude will be required as both an observation and forecast.
- AIM needs: Publication in AIP of the wake separation or wake separation reduction in place.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

The relevant SWIM service for this solution will be the meteorological Information services. In particular, MET information will be used to support different sub-solutions and will be shared via SWIM for both the information production and consumption.

SESAR Solution PJ.02-02: Enhanced arrival procedures

Solution Description:

Satellite navigation and augmentation such as GBAS and SBAS capabilities offers benefits in term of noise management and capacity and efficiency for final approach operations.

This SESAR Solution aims at delivering final approach procedures that foresee glide slope increase and touchdown shift to reduce noise while optimising ROT and contributing to wake avoidance procedures, so that it can also contribute to reduce the need for separation for wake vortex avoidance.

Touchdown shift can be done through:

- The use of a displaced runway threshold (with its corresponding glide slope) that will allow inbound aircraft to the simultaneous use of both thresholds to reduce noise footprint (environmental benefit) while increasing runway capacity (through ROT optimization and reduction or elimination of the need for separation to prevent wake-vortex encounters) or

- The use of multiple runway aiming points that will allow inbound aircraft to reduce noise footprint (environmental benefit) while reducing ROT (potentially leading to increased airport capacity) and increasing runway capacity (through reduction or elimination of the need for separation to prevent wake-vortex encounters).

Glide Slope Increase can be done through:

- Use of Increased Glide Slope (IGS) that will allow inbound aircraft to reduce noise footprint (environmental benefits);

- Using Adaptive Increased Glide Slope (A-IGS) that will allow inbound aircraft to reduce noise footprint (environmental benefits) while optimizing the flight profile (hence, having a potential positive impact on fuel consumption).

The use of double-slope approaches, which consists of the use of two different successive glide slopes, a steeper slope further from the runway which merges with a standard slope in the final approach segment. This allows for inbound aircraft to reduce noise footprint (environmental benefit) in the early portion of the final approach.

The combination of the concepts of glide slope increase with the multiple runway aiming points and displaced runway thresholds can further contribute to both noise reduction and runway capacity increase. These techniques could also be applied small and medium airports whose approach paths are constrained by obstacles.

Research will include how such techniques could improve accessibility to airports for General Aviation (GA) and Business Aviation (BA) aircraft, as well as weather dependent assessment of noise benefits, taking into account the impact of meteorological conditions on noise propagation. Pure MET information will need to be translated to specific operational needs.

The aim is to further investigate the concepts in continuity with SESAR 1 research activities extending the scope to include CATII and CATIII operations and different instrument landing systems. Airborne display cues (e.g. 3D waypoints) could support monitoring of transition or execution of a manual transition. On the ground, it can be anticipated that there will be a need for and HMI evolution to provide the controllers with the means to support the new concepts.

Need for coordination at global level:

The deployment of enhanced arrival procedures requires the GBAS ground system deployed in the airport, the GBAS capability available on board and therefore some synchronisation Air-Ground navaid. Similarly SBAS procedure should be deployed and Aircraft equipped.

Performance Goals:

Depending on the environment, the main performance target could be in capacity or in environment sustainability.

Capacity:

Capacity aspect is currently being assessed within SESAR project 6.8.8. Quantitative assessment is dependent on the airport topology. That said depending on the platform, it is expected that having low noise procedure will allow to remove the curfew and to allow additional slots. Similarly, optimizing runway aiming point will also optimize runway occupancy. Multiple runway aiming points can serve as an enabler for reducing wake turbulence separations as well as reducing the wake vortex encounter risk.

Environmental Sustainability:

A-IGS and IGS will allow a reduction of noise footprint on ground below final approach segment Double slope operations enable noise reduction over sensitive areas by flying higher for longer, thus benefiting from gain of height (increasing noise distance propagation).

Early study have shown a local benefit -3dbAmax on a -4° slope (compared to a -3° GS). A -3.5° A-IGS approach could reduce noise from 1.5dBAmax in the stabilized part of the trajectory (below 1000 ft.); 1 to 3dBAmax benefit in the last.

MRAP brings important noise benefits close to the airport as the noise footprint is shifted accordingly.

Operating Environment:

Both capacity constrained and unconstrained environments.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.02-02
Enhanced arrival procedures</td><th colspan="5">MATURITY</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AO-0308 “Enhanced Arrival Procedures using Displaced Touch Down Zone”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-02a</td><td>Enhanced positioning using GBAS single frequency</td></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>A/C-04</td><td>Flight management and guidance for improved lateral navigation in approach via RNP</td></tr>
<tr><td>A/C-04a</td><td>Flight management and guidance for Advanced RNP</td></tr>
<tr><td>A/C-05a</td><td>APV Barometric VNAV</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-56a</td><td>Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1</td></tr>
<tr><td>A/C-56b</td><td>Flight management and guidance to support GBAS CATII/III using dual GNSS</td></tr>
<tr><td>AERODROME -ATC-70</td><td>Aerodrome ATC system to support displaced touchdown zone operations</td></tr>
<tr><td>APP ATC 116</td><td>APP ATC system to support displaced touchdown zone operations</td></tr>
<tr><td>CTE-N06</td><td>Space Based Augmentation System (SBAS)</td></tr>
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<tr><td>CTE-N07a</td><td>GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
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<tr><td>CTE-N07c</td><td>GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR</td></tr>
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</td><td>V3 on going</td><td></td><td>V3</td><td></td><td></td></tr>
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<tr><td><table><tr><td></td><td>operations, Step 2</td></tr></table></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>AO-0319 “Enhanced Arrival procedures using multiple Runway Aiming Points”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-02a</td><td>Enhanced positioning using GBAS single frequency</td></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>A/C-04</td><td>Flight management and guidance for improved lateral navigation in approach via RNP</td></tr>
<tr><td>A/C-04a</td><td>Flight management and guidance for Advanced RNP</td></tr>
<tr><td>A/C-05a</td><td>APV Barometric VNAV</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-56a</td><td>Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1</td></tr>
<tr><td>A/C-56b</td><td>Flight management and guidance to support GBAS CATII/III using dual GNSS</td></tr>
<tr><td>AERODROME-ATC-25</td><td>Aerodrome ATC system to support multiple runway aiming points operations</td></tr>
<tr><td>APP ATC 115</td><td>Approach ATC system to support multiple runway aiming points operations</td></tr>
<tr><td>CTE-N06</td><td>Space Based Augmentation System (SBAS)</td></tr>
<tr><td>CTE-N07</td><td>Ground Based Augmentation System (GBAS)</td></tr>
<tr><td>CTE-N07a</td><td>GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07b</td><td>GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07c</td><td>GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
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<tr><td>AO-0320 “Enhanced Arrival procedures using Increased Glide Slope (IGS)”</td><td>V3 on going</td><td></td><td>V3</td><td></td><td></td></tr>
</table>

Enabler Code	Enabler Title
A/C-01	Enhanced positioning for LPV/RNP based on Single Frequency SBAS
A/C-02a	Enhanced positioning using GBAS single frequency
A/C-02b	Enhanced positioning using multi constellation GNSS dual frequency
A/C-04	Flight management and guidance for improved lateral navigation in approach via RNP
A/C-04a	Flight management and guidance for Advanced RNP
A/C-05a	APV Barometric VNAV
A/C-06	Flight management and guidance for LPV approach based on SBAS
A/C-32	Flight management and guidance for Increased Glide Slope
A/C-56a	Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1
A/C-56b	Flight management and guidance to support GBAS CATII/III using dual GNSS
AERODROME -ATC-71	Aerodrome ATC system to support Increased Glide slope operations
APP ATC 114	Approach ATC system to support Increased Glide slope operations
CTE-N06	Space Based Augmentation System (SBAS)
CTE-N07	Ground Based Augmentation System (GBAS)
CTE-N07a	GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)
CTE-N07b	GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)
CTE-N07c	GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2
METEO-05c	Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2

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AO-0321 “Enhanced Arrival procedures using Adaptive Increased Glide Slope (A-IGS)”

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-02a</td><td>Enhanced positioning using GBAS single frequency</td></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>A/C-04</td><td>Flight management and guidance for improved lateral navigation in approach via RNP</td></tr>
<tr><td>A/C-04a</td><td>Flight management and guidance for Advanced RNP</td></tr>
<tr><td>A/C-05a</td><td>APV Barometric VNAV</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-39</td><td>Flight Management and Guidance for Adaptive Increased Glide Slope (A-IGS)</td></tr>
<tr><td>A/C-56a</td><td>Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1</td></tr>
<tr><td>A/C-56b</td><td>Flight management and guidance to support GBAS CATII/III using dual GNSS</td></tr>
<tr><td>AERODROME-ATC-72</td><td>Aerodrome ATC system to support Adaptive Increased Glide slope operations</td></tr>
<tr><td>APP ATC 113</td><td>Approach ATC system to support Adaptive Increased Glide slope operations</td></tr>
<tr><td>CTE-N06</td><td>Space Based Augmentation System (SBAS)</td></tr>
<tr><td>CTE-N07</td><td>Ground Based Augmentation System (GBAS)</td></tr>
<tr><td>CTE-N07a</td><td>GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07b</td><td>GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07c</td><td>GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)</td></tr>
<tr><td>METEO-04d</td><td>Generate and provide MET information relevant for Airport and final approach related operations, Step 3</td></tr>
<tr><td>METEO-05d</td><td>Generate and provide MET information relevant for TMA and En-route related operations, Step 3</td></tr>
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<td>V1 on going</td>
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<td>AO-0322 “Enhanced Arrival procedures using double slope approach”
<table>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-02a</td><td>Enhanced positioning using GBAS single frequency</td></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>A/C-04</td><td>Flight management and guidance for improved lateral navigation in approach via RNP</td></tr>
<tr><td>A/C-04a</td><td>Flight management and guidance for Advanced RNP</td></tr>
<tr><td>A/C-05a</td><td>APV Barometric VNAV</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-41</td><td>Flight Management and Guidance for Double Slope Approach</td></tr>
<tr><td>A/C-56a</td><td>Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1</td></tr>
<tr><td>A/C-56b</td><td>Flight management and guidance to support GBAS CATII/III using dual GNSS</td></tr>
<tr><td>AERODROME -ATC-73</td><td>Aerodrome ATC system to support segmented/double slope operations</td></tr>
<tr><td>APP ATC 112</td><td>Approach ATC system to support segmented/double slope operations</td></tr>
<tr><td>CTE-N06</td><td>Space Based Augmentation System (SBAS)</td></tr>
<tr><td>CTE-N07</td><td>Ground Based Augmentation System (GBAS)</td></tr>
<tr><td>CTE-N07a</td><td>GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07b</td><td>GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N07c</td><td>GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
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<td>V3 on going</td>
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The GBAS CATII/III Single frequency solution is linked to the following existing enablers in DS14:

- CTE-N07 Ground Based Augmentation System (GBAS)
- CTE-N07b GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)

- A/C-56a Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1
- BTNAV-0301a, BTNAV-STD-08 Update of ICAO Annex 10 for initial GBAS Cat II/III on GPS L1
- REG-0011 AMC for Initial GBAS Cat II/III
- PRO-069dATC Approach Procedures using GNSS / GBAS
- PRO-AC-56a Cockpit Procedure for GBAS CAT II/III

This solution could be further breakdown into the following points that can be combined:

- Solution PJ.02-02A: Touch down shift
- Solution PJ.02-02B: Glide Slope Increase

Identification of CNS related needs

- GBAS / GBAS Extended service volume
- SBAS

Both GBAS and SBAS can support the enhanced arrival procedures thanks to their flexibilities in providing landing guidance in general. The difference will be in the different decision height that these technologies will enable. However, the actual aspects of real implementation need to be researched, as the requirements on GBAS CAT I and LPV 200 are not the same (e.g. with respect to alert limits).

In addition it has to be assessed, how the on board avionics will incorporate the envisaged arrival procedures. For example, information has to be exchanged on when to switch the glideslope angle during segmented steep / dual slope operations. Especially, if the reference flight path is broadcasted by a GBAS ground station

Identification of MET and AIM related needs

- MET needs; Meteorological (MET) information conditions a number of key elements in Wake Avoidance procedures. The MET information (integration) needs to support the descent profile optimization will be identified, including the required timescales. This will include MET system considerations such as aircraft or aircraft-based wake vortex sensors (LIDAR) to provide real-time spot information and defining the data and quality of service needs for both winds aloft and ground wind speed and direction. *Pure MET information will need to be translated to specific operational needs.*
- AIM needs: TBD

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

Expected information exchange about the final approach segment and potentially MET.

SESAR Solution PJ.02-03: Minimum-Pair separations based on RSP

Solution Description:

The application (by ATC) of pair wise separation (PWS) down to a minimum of 2NM for arrivals on final approach (at the point that the leading aircraft in the pair crosses the runway threshold), based upon Required Surveillance Performance (RSP).

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 the application of pair wise separation to a minimum of 2NM for arrivals on final approach. To this end, there is need to investigate the surveillance technology (e.g. Primary or Secondary Surveillance Radar, Dual-frequency Multi-constellation GNSS/GBAS, WAM) allowing to meet the RSP requirements.

Currently the minimum radar separation on final approach is 3NM when local radar capabilities permit, and may be reduced to 2.5NM between succeeding aircraft which are established on the same final approach track provided:

- The average runway occupancy time of landing aircraft is proven not to exceed 50 seconds.
- Braking action is reported as good and runway occupancy times are not adversely affected by runway contaminants.
- The local radar system has appropriate azimuth and range resolution and an update rate of 5s or less and is used in combination with suitable radar displays.
- The aerodrome runway controller is able to observe the runway-in-use and associated exit and entry taxiways.
- The wake turbulence radar separation minima do not apply.
- Aircraft approach speeds are closely monitored by the controller and when necessary adjusted so as to ensure the separation is not reduced below the minimum.
- Aircraft operators and pilots have been made fully aware of the need to exit the runway in an expeditious manner.
- Procedures concerning the application of the reduced minimum are published in AIPs.

Similar restrictions are anticipated with respect to the application of the 2NM MRS.

Need for coordination at global level:

The application of the 2NM MRS is a local decision. The RSP and associated restrictions should be coordinated globally as per the current 2.5NM MRS.

Dependencies:

Potential coordination would be needed with PJ.14.

Performance Goals:

Capacity:

- Expected runway throughput increase up to 20% mainly for arrival (depending on traffic mix) during peak periods, at constrained airports
- The increase of capacity will be directly proportional to the proportion of NON-wake constrained pair (without Heavy in front) in the peak hours.
- This will be particularly efficient for[3]
    - Congested secondary airport with limited number of Heavy (<10% in peak) like: Munich, Copenhagen, Oslo, Stockholm, Barcelona, Palma de Mallorca, Vienna, Brussels…
- congested major airport during traffic peak with limited number of Heavy, typically afternoon peak of: Frankfort, Amsterdam, Roma, Zurich
- The expected benefit can be quantified as followed (A380 not considered) :
    - An increase of 25% runway throughput for 0% Heavy in the traffic mix
    - An increase of 20% runway throughput for 10% Heavy in the traffic mix
    - An increase of 15% runway throughput for 30% Heavy in the traffic mix

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[3] *CFUM data 2014*

  - An increase of 10% runway throughput for 50% Heavy in the traffic mix
- With 10% A380 in the traffic mix
  - An increase of 20% runway throughput for 0% Heavy in the traffic mix
  - An increase of 15% runway throughput for 20% Heavy in the traffic mix
  - An increase of 10% runway throughput for 40% Heavy in the traffic mix

Operational Efficiency and Resilience:

- Reduction of airborne delays due to arrival capacity limitations linked to MINIMUM RADAR SEP.
  - For airports that are today constrained in peak hours, the use of reduced minimum radar separations to 2Nm can either be translated into added capacity (as described above) or additional resilience in case of perturbation.
  - Using similar approach as the one developed by the French STAC (Service Technique de l'Aviation Civile) for RECAT-EU in CDG, the use of reduced MRS for a test case: LVP condition imposed during the morning peak has shown a reduction
  - 50% reduction of recovery time (time to come-back to nominal planning)
  - 30% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)
- Increase flexibility for Controllers to manage the arrival traffic due to the separation minima reduction Resilience would further benefits of the above mentioned goals.

Operating Environment:

Capacity constrained airports, medium and big airports.

The diversity of traffic type expected to use different categories of airports is becoming more and more problematic to handle the mix of traffic by the ATC. The possibility for the ATC to reduce the separation between aircrafts to 2NM based on RSP will improve the landing rates and fulfil the different airport users' needs by making the management of many types of traffic more acceptable for the ATC.

Reduced surveillance separations and associated increase of runway throughput will benefit to all airspace users that are constrained by runway capacity during peak hours when surveillance separations are frequently applied and where other operation constraints (e.g., Runway Occupancy Time) don't become the bottleneck.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.02-03
Minimum-Pair separations based on RSP</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AO-0309 "Minimum-Pair separations based on RSP"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>APP ATC 159</td><td>Adapt STCA for Pairwise Separation Based on Required Surveillance Performance</td></tr>
<tr><td>CTE-S01</td><td>Secondary SUR Radars</td></tr>
<tr><td>CTE-S01a</td><td>SSR Mode A/C/S</td></tr>
</table></td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
</table>

CTE-S02	Primary SUR sensor					
CTE-S02a	Primary Surveillance Radar					
CTE-S04a	Wide Area Multilateration (WAM)					
METEO-03	Provision and monitoring of real-time airport weather information, Step 1					
METEO-04b	Generate and provide MET information services relevant for Airport and final approach related operations, Step 1					

Identification of CNS related needs: Performance of following (non-exhaustive list)

- Secondary SUR Radars;
- SSR Mode A/C/S;
- Primary SUR sensor;
- Primary Surveillance Radar;
- Wide Area Multilateration (WAM);
- ADS-B;
- GBAS.

Identification of MET and AIM related needs

- No MET related needs expected
- AIM needs: Publication in AIP of the surveillance separation reduction in place.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None

SESAR Solution PJ.02-05: Independent rotorcraft operations at the airport

Solution Description:

This SESAR Solution aims at improving the access into small airports in low visibility conditions through the development and the publication of Approach Procedure with Vertical Guidance at secondary airports by using Rotorcraft specific independent IFR procedures to/from FATO (Final Approach & Take-Off area) located at airports. This will remove IFR rotorcraft from active runways and allow fixed wing aircraft and rotorcraft simultaneous non-interfering operations (SNI). This rotorcraft specific independent IFR procedure will include a Point-in-Space (PinS) to enable access to/depart from VFR FATO.

Rotorcraft operation in good weather is generally not an issue, when rotorcraft can use VFR approaches to runway or FATO; dedicated VFR approaches to FATO often enable independent fixed wing aircraft and rotorcraft operations. It is of concern when adverse weather is below the VFR minima and IFR departure and approach procedures must be used.

The use by rotorcraft of the same IFR approach procedures as fixed wing aircraft is too constraining for rotorcraft, which would be able to use shorter steeper descent profiles, and can do tighter turns. Moreover, the lower speed profile used by rotorcraft often forces air traffic services to delay them due to the interference to their interference with fixed-wing traffic. Management of the combination of fixed-wing and rotorcraft is complex for controllers due to their different performances.

With the introduction of PBN concept (RNP), the route structures can be optimised. In this respect GNSS- based procedures with vertical guidance may represent a valid solution, because they provide a reliable and accurate means of navigation for operations, which allow to develop dedicated and tailored routes in addition to instrument flight procedures to/from airport, completely decoupled from the traditional navigation aids (e.g. NDBs, VORs, ILS) and from fixed-wing aircraft procedures, thus limiting strategically their interference (SNI concept) with fixed wing operations.

Dedicated IFR procedures with the vertical guidance (GNSS-based e.g. APV SBAS/Baro) designed for Rotorcraft (CAT H) represent a valid mean to guarantee access to FATOs (currently only VFR operations to FATO are allowed) landing locations where conventional flight procedure cannot be developed;

Dedicated IFR SNI concept can provide an alternative IFR capability to small airports where the installation of traditional navigation aids is not financially viable or unfeasible due to other specific constraints. In this way, rotorcraft operations, and in particular HEMS rotorcraft operations will no longer be limited to VFR/VMC conditions and night operations will become safer.

The peculiar rotorcraft capabilities of tight turns, steep climb and descent, combined to dedicated IFR procedures based on GNSS and the PBN navigation specification within low level IFR routes, will not only allow to avoid the interaction of rotorcraft with fixed-wing aircraft, but also more optimal operations in obstacle-rich urban environments and noise sensitive areas.

Performance Goals:

The implementation of rotorcraft specific approach/departure procedures based on PBN navigation specifications at busy airports will improve:

- Access & Equity
- Airport capacity
- Operational efficiency
- Environmental impact (reduced impact).
- Costs (reduced costs)
- Interoperability
    - The solution may have impact on Interoperability as it needs to be interoperable with surface movement and gate allocation for flights currently not allowed to operate in adverse weather conditions at the airport, and for sequencing and merging in APP to be integrated with IFR flights.

Operating Environment:

Small / medium airports with a significant number of rotorcraft operations.

List of OI steps and enablers:

SOLUTION PJ.02-05 Independent Rotorcraft IFR operations at the Airport	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AO-0316 "Increased Airport Performance through independent IFR rotorcraft operations"	V3 On going		V3		

Enabler Code	Enabler Title
A/C-04	Flight management and guidance for improved lateral navigation in approach via RNP
A/C-06	Flight management and guidance for LPV approach based on SBAS
A/C-07	Flight management and guidance for RNP transition to ILS/GLS/LPV
AIMS-23	Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements
METEO-03c	Provision and monitoring of real-time airport weather information, Step 2
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2
METEO-05c	Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2

Identification of CNS related needs

- Approaches with vertical guidance (safety impact)
  - LNAV/VNAV (Baro VNAV flown as pseudo ILS)
  - LPV (Localizer performance Vertical guidance)
- Approaches off-shore
  - Using GNSS
  - SBAS
  - GBAS
- ADS-B OUT in order to replace conventional Radar surveillance
- ADS-B IN for enhance traffic situational awareness and self-separation

Identification of MET and AIM related needs

- Rotorcraft operations require specific meteorological- (MET) and aeronautical- (AIM) information unique to the specific operational constraints imposed which is not necessarily available or shared today. As such a common operating picture between rotorcraft operations and other operations is often missing. The MET and AIM information needs to support such a common operating picture or the integration of this information by support systems. *Pure MET information will need to be translated to specific operational needs.*

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Considering the specific rotorcraft operation scenario some of them are conducted at very low level in remote areas where the ability to interface with SWIM may be limited. SWIM performances in "non-standard, non-conventional" environment (e.g. remote areas) could\should be evaluated, and the concern is when airborne for rotorcraft not fitted with data-link can use the GSM technology as enabler.

SESAR Solution PJ.02-06: Improved access into secondary airports in low visibility conditions

Solution Description:

New airborne capabilities such as RNP and GNSS based Landing Systems will ultimately enable aircraft to make an approach in low visibility conditions at any location. This improvement is realized by extending the IFR segment down to 100 ft. using LPV operations. Then, the Combined Vision System, which capabilities will be assessed in the PJ.03a-04 solution, may ultimately enable the pilot to safely land the aircraft and vacate from the runway down to 0 RVR.

LPV 100 can be supported by GBAS Cat II in the short term. In the longer term, LPV 100 would be realized using SBAS based on Multi Constellation Multi Frequency.

Requirements will be provided for these operations based on cooperation with PJ.14 (CAT II equivalent operations based on MCMF SBAS). Assessment of feasibility, trade-off between benefits and complexity of possible solution will be carried out.

There is a need to evaluate the minimum level of secondary airports infrastructure, services and procedures in order to benefit from these capabilities, considering the new technologies involved, such as SBAS, and the particular context of small airports with limited demand. These technologies would improve capacity, thanks to improved use / access to secondary airports and thus improve capacity in the overall European network. Small airports would be able to provide these low visibility operations with increased cost efficiency (e.g. without ILS) and with benefit to safety, thanks to increased situational awareness.

There is a need to consider the airborne requirements of BA and GA operators, in coordination with PJ.13.

In addition, it will be assessed whether a single GBAS ground station can enable approach operations during low visibility conditions at a secondary airport without other significant infrastructure. This could provide a cost-efficient solution to enable safe approach procedures with vertical guidance.

R&D will start focussing on the definition of what type of lighting, services (e.g. runway and approach clearance monitoring) and procedures (e.g. displaced threshold to ensure sufficient clearway) are needed to enable LVP operations at secondary airports.

With the PJ.03a-04 solution results, there is also a possibility to check whether SBAS (which supports

RNP APCH down to LPV minima) can enable Cat III operations in LVP when combined with CVS.

__Need for coordination at global level:__

A network coordination is anticipated as the inclusion of different sensors and observations provides network – wide opportunity for improve the accessibility of small airports and Air/ground – ground synchronized deployment is required

__Performance Goals:__

- Capacity:
    - Expected major airport capacity increase by 3 to 5% by allowing the use of secondary airport in LVP.
- Safety:
    - Increase of safety associated with increased awareness for the pilot.
- Flexibility:
    - At secondary airports 15% increase of traffic capable with operating in LVP.

__Operating Environment:__

- Secondary airports

__List of OI steps and enablers:__

<table>
<tr><td rowspan="3">SOLUTION PJ.02-06
Improved access into secondary airports in low visibility conditions</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td></td><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>SDM-0301– “Improved access into small airports in low visibility conditions”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01b</td><td>Aircraft capability to support Multiple Constellation / Multiple Frequency SBAS LPV 100</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-23b1</td><td>Combined Vision for Equivalent Visual Landing operations in LVC</td></tr>
<tr><td>A/C-56a</td><td>Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1</td></tr>
<tr><td>AERODROME-ATC-06</td><td>Surface movement control workstation equipped with tools for conflicting ATC clearances detection and alerting for Runway operations</td></tr>
<tr><td>AERODROME-ATC-52</td><td>Provide Remote Tower Controller position with visual reproduction of both remoted aerodrome views</td></tr>
</table></td><td>Not Addressed</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

	and other sensor data.					
AERODROME-ATC-53	Remote Tower controller position enhanced with additional sources for low visibility conditions					
AERODROME-ATC-75	Remote Tower Module for provision of MET conditions reproduction					
AERODROME-ATC-76	Capability for broadcast of Runway Status based on video surveillance					
AGSWIM-41	AGDLGMS in support to provide extended OTIS to the aircraft					
AIMS-16	Electronic Terrain and Obstacle Data (TOD)					
AIMS-23	Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements					
CTE-N06	Space Based Augmentation System (SBAS)					
CTE-N07b	GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)					
ER APP ATC 77	ATC Systems enhanced to exchange real-time (tactical) airspace status data with ASM support system					
METEO-03c	Provision and monitoring of real-time airport weather information, Step 2					
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2					

Identification of CNS related needs

LPV 100 ft. requirements should be defined (NSE, time to alert, continuity, availability, etc.) so as to be agnostic from the underlying technology SBAS or GBAS. The mapping of CNS related requirements with GBAS GAST D should be based on SESAR 1 reports. It is expected that LPV 100 requirement will drive most of SBAS MCMF technology requirements in terms of integrity, availability and continuity.

A GBAS ground station at a secondary or small airport introducing challenging siting requirements

Navigation needs:

- SBAS /GBAS GNSS receivers - Multi-Constellation / Multi-Frequency GNSS (GPS + GALILEO / L1 + L5)
- Attitude and Heading Reference Systems (required for both head down synthetic vision systems and augmented reality head-up displays)
- Alternative Sources of navigation information (in case of GNSS outages)

Communication needs:

- Airport air-ground datalink
- Broadcasting system (e.g. D-OTIS)

Surveillance needs:

- ADS-B/MLAT surveillance
- Camera system

Identification of MET and AIM related needs

To introduce procedures that enable equivalent Cat I, II or III operations on smaller airports requires MET and AIM information that will support decision makers to make the appropriate decisions as where they executing Cat I, II or III operations. The current systems, procedures and information exchanges at and for the considered smaller airports should not be assumed to be in place. Therefore the required MET and AIM information will be defined to improve the access to smaller airports in low visibility conditions.

- AIM needs:
    - Availability/access to up-to-date terrain/obstacles/aerodrome mapping database
    - Dynamic information associated to the real time conditions of access to small airports should be provided via AIM services so as to minimize flight crew analysis of the applicable aircraft capabilities and crew qualification
    - For example, if RAIM Prediction is still needed with MCMF GNSS, this information may be included in a service supporting crew assessment of the availability of SBAS LPV procedures at a given airport at the estimated time of arrival.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- AIM service above should be a SWIM service.

SESAR Solution PJ.02-08: Traffic optimisation on single and multiple runway airports

Solution Description:

This SESAR Solution provides dynamic assistance to the Tower and approach controllers to optimize runway operations, and make best use of minimum separations, runway occupancy, runway capacity and airport capacity, supporting ATC for the decision process (when and how to mix runway operations) resulting in an optimized use and enhanced management of runway capacity throughout the day of operations.

Basically, the mixed mode operation concept is addressing one runway. Here the concept is also extended to all airport runways and a decision support tool will help ATC to select the most efficient airport operational configuration in any traffic and weather condition.

The solution also enables complementary and optimized spacing of arrivals and departures reflecting new wake turbulence separations and reduced and predicted runway occupancy (taking benefit of ROT performances provided by the flight crew).

This solution will assign arriving and departing flights to a specific runway and will produce an optimal aircraft sequence on all runways. Work is needed to determine the right time to freeze these decisions: too early and the decisions may not be optimal, too late and the result will be excessive controller workload and inefficient trajectories.

Overall planning will be performed by an Enhanced Coupled AMAN-DMAN, and the project will address the method in which sequence planning information should be presented to controllers.

The coupled AMAN/DMAN, supported by Airport DCB monitoring and management (RMAN), will propose a fully integrated sequence at the runway threshold/gate in trajectory based operations. The coupled AMAN/DMAN solution will use SWIM services (either already available or to be specifically designed/developed/enhanced in the context of this solution) for all required exchanges of departure, arrival and network management data. The airport component of the coupled AMAN/DMAN solution must be independent from the TMA component while being fully interoperable. Surface movement tools, in addition to AMAN/DMAN, need to be considered for ROT optimization to allow departures to be timely manner in line-up queue and to integrate arrivals approaching in different glide slopes, at different runway thresholds, with different landing systems (ILS/ SBAS/ GBAS ad mixed fleet rotorcraft, GA, IFR). In addition the integration need to consider the expected line-up time in order to timely fill a departure gap after a landing A/C and to meet the TTOT to fully support the sequence optimization. Interfacing with Surface Movement tools will be performed using SWIM services.

The landing, if equipped, shall follow its preferred trajectory to meet the TLDT, both with enhanced accuracy. To meet the new minimum separations and optimize the ROT, the integrated runway sequence shall have tailored gaps between landing A/C.

A fully integrated approach to analyse and estimate the possible airport runway configurations (taking in consideration an high number of constraints), impact of external conditions (e.g. meteorological observation and forecast, runways maintenance, accidents, noise procedures abatement, etc..) and current traffic load, represent a great benefit able to provide the operator with the possibility to determine the optimum runway configuration to minimize flight delays and optimize the use, the planning and the management of airport resources contributing to a better common situational awareness.

Pure MET information will need to be translated to specific operational needs. In particular the above information regarding the result of performances optimization in terms of runway configurations and capacities shall be available to the relevant airport operational actors since their awareness may greatly improve airport operations and coordination among the various operational entities. The information sharing will be basically performed by SWIM services either already defined in SESAR1 or to be specifically designed/developed/enhanced in the context of this solution.

In order to reach the integration, the solution needs coordination with the other PJ.02 solutions to integrate the potential changes.

PJ.02-08 will develop a solution as integration of multiple concepts operating in both Execution and Planning Phases (Short and Medium term) able to support the operational entities (Tower Operator, Supervisors) in monitoring and optimizing the use and changes of the Runway system. . Coordination with PJ.01, PJ.03a and PJ.04 is required to agree on a common architecture. For instance it will be clarified at an early stage whether AMAN/DMAN and A-SMGCS systems have to exchange data directly or whether they go through the AOP. Dataflows between PJ.01, PJ.03a and PJ.04 solutions will be clarified and agreed with these projects.

<u>Need for coordination at global level:</u>

No air ground synchronization deployment is expected

<u>Performance Goals:</u>

Airport Demand and Capacity balancing is expected to be validated in SESAR1 (V3) considering airport and weather information for segregated runways. The integration of arrival and departure information for mix mode runways and an agile synchronization with the Coupled AMAN/DMAN can improve the orchestration of ATC and surface management services.

- <u>Capacity</u>
  - Detect Demand & Capacity imbalances during the Medium /Short Term planning can increase runway throughput up to 10-15% depending on the airport layout, traffic mix and weather conditions.
  - For airports constrained at peak hours, the use of the optimum runway configuration can either be translated into added capacity (reducing lost slots) or additional resilience in case of perturbation.
  - The use of new PWS and predicted ROT will allow removing operation buffers providing additional slots.
- <u>Predictability</u>
  - A more realistic and precise accuracy on landing and departure times will increase predictability allowing airspace users to better planning of the ATV avoiding passengers delays and cancelations during the execution phase.
- <u>Efficiency</u>
  - Imbalances known more than 3 hours ahead allow to re-planning inbound traffic in the origin airport or reconsider ATV on behalf of airlines reducing delays due to airport constraints up to 20%.
  - It is expected that planning runway closures or runway changes along the day in the optimum periods will minimize the time spent re-routing air and ground traffic during the execution phase. Sharing this information with the different actors allow to provide NOP with more accurate forecasted times for arrivals and departures in order to coordinate the consequent target times.
  - Reduction of airborne delays due to a planned arrival capacity limitations has a direct impact on fuel costs and emissions
  - By adjusting speeds to be in accordance with expected time to land, by planning to start engines at the right time to meet expected time for departure, airspace users will reduce their fuel consumption.
- <u>Safety</u>
  - Increasing runway throughput in terms of 10-15% and increasing capacity regarding recovery of lost slots will lead to an associated improvement in safety so that the total number of ATM-induced accidents and serious or risk bearing incidents would not increase despite traffic growth;
- <u>Human Performances</u>
  - Considering the current maturity level of the proposed solution, it is expected a quantitative effect on Human performances due to a more efficient operation derived from better forecasted situation avoiding the Supervisor and ATCOs answering in a reactive manner.

<u>Operating Environment:</u>

Capacity constrained airports.

List of OI steps and enablers:

SOLUTION PJ.02-08 Traffic optimisation on single and multiple runway airports	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
TS-0301 "Integrated Arrival Departure Management for full traffic optimisation on the runway"	Not addressed	V1	V2	V3	
TS-0311 "Optimised and improved predictability of RWY capacity using better predictable ROT"	Not addressed	V1	V2	V3	

TS-0301 "Integrated Arrival Departure Management for full traffic optimisation on the runway"

Enabler Code	Enabler Title
AERODROME-ATC-09c	Improvement of operational orchestration among arrival / departure management and surface management services
AERODROME-ATC-33	Airport Demand and Capacity system enhanced to better handle arrival and departure
AERODROME-ATC-57	Advanced CWP to support improved runway management concept
AERODROME-ATC-58	Agile synchronisation of arrivals with departure information for the same airport
ER APP ATC 51a	Agile synchronisation of arrivals with departure information for the same airport
METEO-03c	Provision and monitoring of real-time airport weather information, Step 2
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2
NIMS-12	Demand Capacity Balancing equipped with a tool to identify and arbitrate multiple imbalance and hotspots
SWIM-APS-07b	Consumption of Meteorological Information services for Step 2
SWIM-APS-08b	Provision of Airport Information services for Step 2
SWIM-APS-09b	Consumption of Airport Information services for Step 2

TS-0311 "Optimised and improved predictability of RWY capacity using better predictable ROT"

Enabler Code	Enabler Title
AERODROME-ATC-27	Runway Usage Management sub-system enhanced to improve Runway capacity in the planning phase
AERODROME-ATC-34	Airport Demand and Capacity system enhanced to use reduced and predicted ROT
METEO-03c	Provision and monitoring of real-time

	airport weather information, Step 2					
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2					
TS-0313 “Optimized use of runway capacity for multiple runway airports (mixed mode decision tool)”		Not addressed	V1	V2	V3	
Enabler Code	**Enabler Title**					
AERODROME-ATC-29	Enhanced Airport Demand and Capacity system for mix mode runways					
AERODROME-ATC-57	Advanced CWP to support improved runway management concept					
AERODROME-ATC-74	Airport Demand and Capacity system enhanced for multiple runway airport					
METEO-03c	Provision and monitoring of real-time airport weather information, Step 2					
METEO-04c	Generate and provide MET information relevant for Airport and approach related operations, Step 2					

Identification of CNS related needs

- No needs identified

Identification of MET and AIM related needs

- Individual AMAN and DMAN identified individual MET and AIM information needs. It will be investigated if the MET and AIM information that is sufficient to meet these individual needs is also sufficient when AMAN and DMAN are coupled. Based on this assessment separate MET and AIM information needs could be identified.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Expected relevant SWIM services for Data exchanges for Coupled AMAN/DMAN and A-SMGCS

SESAR Solution PJ.02-09: Enhanced Runway Condition Awareness

Advanced systems (e.g. built-in runway sensors, runway condition models, weather forecast) are used as inputs to a ground-based ROT prediction tool, which uses them to assess runway breaking action. A ground-based ROT prediction tool will use this data as input, and combine it with statistically processed observed ROT from real operations. This tool will take each individual aircraft’s A/G ROT prediction downlink where available, and will produce a ground-predicted ROT for each flight. Flight plan data and information on on-board breaking systems equipage - EBS/non-EBS - information when A/G downlink of predicted ROT is not available (due to either lack of equipage or lack of ground infrastructure to process the A/G downlinked prediction). In this way, predictability of ROT and runway exit is increased both for arrivals and departures.

Predicted ROT will be fed to AMAN/DMAN tools, and possibly to Surface Management Tools. Final approach CWP may present information based on predicted ROT to support reduced separation behind

EBS-equipped aircraft. Maximum benefit can be expected in mixed-mode use runways.

This solution could consider input from other PJ.02 solutions such as PJ.02-02 and would need the elaboration of a standard for aircraft sensed friction addressing minimum requirements for producing and transferring the data and the integration of the data in decision making process.

Need for coordination at global level:

Solution improves airports operating environment. Data provided to ATC (TWR, APP) and systems will be used for provision of efficient and safe operations. A/G coordination is required for synchronized deployment

Performance Goals:

- Safety:
    - Inconsistency with actual aircraft braking performance is the main shortcoming of conventional reporting means of runway condition. Runway found more slippery than reported by flight crews is a common contributing factor to runway excursions. The deployment of aircraft sensed runway slipperiness should enable to connect runway condition reporting with actual aircraft braking performance and mitigate runway excursion risks which is the highest accident / incident exposure (IATA Safety Report 2014).
    - The non-intrusivity of proposed methods will enable to enhance significantly the measuring rate of runway condition during winter operations (e.g. at least 20 times when using aircraft sensed data).
    - Modelling of runway condition is significantly improving the quality of information presented to the crew before runway operation.
- Capacity:
    - Real-time and non-intrusive update of Runway Condition information through accurate knowledge of current and predictive aircraft braking performance should enable to avoid runway closures for friction measurements (20-30mn per closure) and potentially induced delays due to unavailability of the runway.
    - Modelled data improved by the information received from on-board systems will improve planning of runway use and will provide most precise information for capacity planning.
    - Proposed methods will enable state-of-the-art predictability of runway conditions which are considered vital for improvements of AMAN / DMAN calculations at congested airports.
- Resilience:
    - The methods proposed in the PJ.02-09 offer a better resolution than conventional tools to assess runway condition. These methods are expected to enable airports to maintain normal operation conditions for a longer time period before having to revert to degraded operation conditions (runway closures, reversion to operations on the longest runway only both for departures and landings, etc.).

Operating Environment:

All categories of airports, a better and more reliable Runway condition status, achieved through sharing the same set of data, and Runway Friction status will increase efficiency and will support safety for airport users.

<u>List of OI steps and enablers:</u>

<table>
<tr><td rowspan="4">SOLUTION PJ.02-09
Enhanced Runway Condition Awareness</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AUO-0606 “Improved Runway Friction Status”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-64</td><td>New onboard sensors to provide Friction data of runway</td></tr>
<tr><td>AERODROME -ATC-45</td><td>Communication DataLink supporting trajectory management and other flight information during approach, landing, and taxi and departure.</td></tr>
<tr><td>AERODROME -ATC-47</td><td>Airport ATC Subsystem to incorporate aircraft broadcasted runway friction data</td></tr>
</table></td><td>Not Addressed</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
<tr><td>AUO-0704 “Predicted Runway Occupancy Time (ROT) using aircraft performance”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-37b</td><td>Downlink of additional onboard data according to new standard</td></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>A/C-66</td><td>Onboard prediction of line up / take off and runway occupancy times at departure</td></tr>
<tr><td>AERODROME -ATC-55</td><td>Airport ATC analyser tool for predicting ROT</td></tr>
<tr><td>AERODROME -ATC-56</td><td>Airport ATC Function exchange current ROT information between a/c and ATC Systems</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
</table></td><td>V2</td><td>V3</td><td></td><td></td><td></td></tr>
</table>

__Identification of CNS related needs__

- Airport ATC subsystem to incorporate aircraft broadcasted runway friction data,
- Airport ATC database to accumulate data from weather based models, sensors and aircraft data,
- A/G Datalink

__Identification of MET/AIM related needs__

- Weather – dependent runway friction model, runway friction coefficient, weather forecasts,
- Incorporation of weather data from cockpit into the runway condition modelling,
- Incorporation of weather from local ground sensors into the runway condition modelling,
- Weather – based runway condition model

__For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services__

- Expected (relevant SWIM services for Data exchanges for AMAN/DMAN and A-SMGCS),
- SWIM services for data exchange for airport/approach systems (capacity management).

SESAR Solution PJ.02-11: Enhanced Terminal Area for efficient curved operation

Satellite navigation and augmentation such as GBAS and SBAS capabilities offers benefits in term of capacity and efficiency in approach. GNSS can also provide benefits in the Terminal area.

3 operational axis need to be further assessed:

- Use of Geometric altitude (GNSS based): Enhanced Safety can be offered in the terminal area to link the vertical trajectories in the STAR and the final approach (by GBAS or SBAS). This can also offer opportunities for optimised three dimensional routes minimising level-offs. Environmental benefits can be expected in terms of reduced emissions and especially reduced noise.
- Curved procedure: GNSS based navigation provides the ability to change or create approach procedures without infrastructure changes. Advanced arrival procedures can be designed in the whole Terminal area down to the runway (even in all weather conditions with GBAS). Efficiency benefits linked to reduced air traffic controller workload may be obtained.
- Extended service volume for GBAS: current Dmax range (23Nm) provides limited service to the approach. Extension of service should be brought to ICAO and standardisation bodies.

There is an operational need to allow the use of curved segment as close to the runway as possible to optimize procedures in terms of fuel consumption or noise abatement. One solution has been studied in SESAR 1: RNP transition to xls.

During the transition, the pilot has to monitor the primary guidance modes all along the approach The aircraft guidance modes during the RNP part and the xls part are usually not the same: the flight guidance computer will switch from the RNP to the xls guidance modes. The vertical RNP part of the approach procedure is computed on a barometric reference and the vertical guidance of the xls part on a geometric reference. The aircraft systems will also switch from a barometric to a geometric reference. Therefore, pilot workload will be increased due to the monitoring of the transitions.

Depending on the capability of aircraft systems, the transition may occur at a different location along the approach. Furthermore the approach is composed of 2 separate segments. This will induce additional ATC workload. The risk of Go Around, in case the xls guidance modes do not engage, is also higher than in a conventional procedure.

Using Geometric altitude and advanced arrival procedures will allow removing the drawback of the transition (crew and ATC workload reduced) and increasing efficiency and predictability (single operation).

Using Aircraft capability based on metric Flight management and guidance will allow much more precise navigation in the TMA.

If SBAS enabler is designed for Navigation, GBAS has been developed as an Approach technology. Therefore the GBAS concept has to be revisited to include this extended usage (GBAS extended service volume).

Several operational aspects need to be studied such as transition to Geo reference from En-route to TMA, mixed mode operation (Baro and metric).

This PJ.02-11 solution will be an enabler for CSPO (SESAR solution PJ.01-07) and can provide additional benefits if coupled with Enhanced arrival procedures (SESAR Solution PJ.02-02).

Activities to be done

- Definition of Enhanced Terminal Area concept: OSED, SPR, INTEROP
- Mock up definition and specs
- Early HF assessment
- Cockpit and procedure Harmonisation and simplification

Need for coordination at global level:

The deployment of enhanced arrival procedures requires the redesign of TMA based on GBAS ground system deployed in the airport, and/or SBAS augmentation and therefore some synchronisation Air-Ground navaid, GBAS and SBAS procedure as well as Aircraft capability are required.

Performance Goals:

- Human performances:
    - Considering the current maturity level of the proposed solution, quantitative prediction of the effect cannot reasonably be provided. That said Human performances are expected to be considerably alleviated as the restructuration of TMA will allow more efficient operation (flow segregation and in term of approach design as this will allow shorter final segment and so later turn). The procedure will be designed from the entry into the TMA down to the runway (even down to Cat II/III operation).

Operating Environment:

All categories of airports.

<u>List of OI steps and enablers:</u>

SOLUTION PJ.02-11 Enhanced Terminal Area for efficient curved operation	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AOM-0607 "Enhanced Terminal Area for efficient curved operation"				V1	V2

Enabler Code	**Enabler Title**
A/C-02c	Enhanced Vertical positioning based on GNSS extended to TMA operation
A/C-81	Flight management and guidance for Curved procedures with Autoland
AERODROME-ATC-77	Aerodrome ATC system to support efficient curved operation in final approach
APP ATC 119	System Support for Curved Approaches Using Geometric Altitude
CTE-N06	Space Based Augmentation System (SBAS)
CTE-N07d	GBAS service volume extension

<u>Identification of CNS related needs</u>

- GBAS Extended service volume
- SBAS

<u>Identification of MET/AIM related needs</u>

- Not expected

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Not expected at this stage

Performance Goals

The main Performance Goals are as following:

- Maintaining or increasing runway safety levels;
- Increasing environment sustainability;
- Increasing airport efficiency and capacity;

- 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;
- Improve access to secondary airports;
- Increase situational awareness;
- Increasing predictability (e.g. of the landing rate, of Runway Occupancy Time, runway exit and departure rotation) (predictability refers here not only to G2G variability, but also to predictions of landing rates, ROT, runway exit and departure rotation that are used as input to support tools");
- Reducing fuel consumption, thus increasing environmental sustainability, and Reduction of noise in the vicinity of an airport;
- Increasing or maintaining acceptability: ATC Workload maintained or reduced;
- The opportunity to realize higher system robustness, with improved continuity of service under low visibility conditions at the airport (CATII/III) and with expected benefits for resilience, cost-efficiency and providing increased flexibility under non-nominal conditions at the airport.

In the table below the performance goals identified are detailed for each PJ.02 solution with the expected relevant target (H, M, L); when the cell is leaved blank the performance goal is expected to be maintained at the same level, so this is not aimed at preventing any analysis in the performance area.

	Capacity	Efficiency	Predictability	Flexibility	Safety	Resilience	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.02-01 **Wake Turbulence Separations Optimization**	**H**	**H**	**M**	**L**	**M**	**M**	**M**						**M**
SOLUTION PJ.02-02 **Enhanced arrival procedures**	**H**	**M**							**H**				**M**
SOLUTION PJ.02-03 **Minimum-Pair separations based on RSP**	**H**	**H**				**M**	**M**						**M**
SOLUTION PJ.02-05 **Independent Rotorcraft operations at the Airport**	**M**	**M**	**H**	**M**	**M**	**M**	**M**		**M**	**L**			**L**
SOLUTION PJ.02-06 **Improved access into secondary airports in low visibility conditions**	**H**		**M**	**L**	**M**								
SOLUTION PJ.02-08 **Traffic optimisation on single and multiple runway airports**	**H**	**M**	**H**	**L**		**M**	**M**		**L**				**L**
SOLUTION PJ.02-09	**L**	**H**	**M**		**M**	**M**	**M**						**M**

Enhanced Runway Condition Awareness													
SOLUTION PJ.02-11 **Enhanced Terminal Area for efficient curved operation**	**L**		**M**	**M**	**M**		**H**		**L**				**L**

Performance goals rationales:

- SOLUTION PJ.02-01 Wake Turbulence Separations Optimization

The SESAR-2 individual solutions integrated with time based (before but not combined with each other) and their quantified effect are described below:

- **TBS pair wise separation (RECAT-2 + TBS) - AO-0306 + AO-0303 _**
  - The application (by ATC) of pair wise separations (RECAT-2) for arrivals on final approach and for departures from the runway for the initial common departure path, by taking into account aircraft characteristics of the lead and follower aircraft (such as maximum landing weights and speed profiles), that impact the strength of the wake generated by the lead aircraft or the resistance of the follower aircraft to a wake encounter.
  - The pairwise separations will be applied on a time based basis and using an optimised runway delivery support tool. There is the need to underline that solution defining optimised 6 categories scheme as a function of local traffic mix will also be proposed for being used at a low-cost without ATC support tool.
  - The optimisation of the full RECAT 2 (S-PWS) matrix to give the ANSPs the opportunity to form larger number of 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 that may (optional and remaining deployed at local level) use downlinked information from aircraft for optimising runway delivery.
  - All provided impacted on capacity, Operational Efficiency and Resilience have been produced using the methodology jointly developed by the French Service Technique de l'Aviation Civile (STAC) and EUROCONTROL[4].
- Capacity:
  - Expected runway throughput increase by 5 to 10% on both arrival and on departure (depending on traffic mix) during peak periods, at constrained airports

    This can be quantified in term of additional movement per airport in peak hour in comparison to application of current ICAO separations if TMA (dependency with PJ-01) and ROT (dependencies with Solutions 7 and 9) don't become the bottle necks for example:
  - 9 additional arrival movements per day in EHAM
  - 15 additional arrival movements per day in LFPG

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[4] DGAC/STAC: Expertise d'évaluation des gains en capacité du projet RECAT-EU – Ref. 14_0506_D_REXP_STAC_ACE_CS

  - 20 additional arrival movements per day in EGLL (10 in the morning peak)
  - 24 additional arrival movements per day in LTBA
  - 30 additional arrival movements per day in EDDF

  Over the next 20 years, many additional EU airports will become capacity-constrained as predicted by the '**Challenge of Growth**" study (source: EUROCONTROL) and will benefit from the previous solution.

  The reduction of wake turbulence separation on departure will allow an overall increase in runway capacity and avoid congestion from the increase in the arrival traffic flow.

- Operational Efficiency and Resilience:
  - Reduction of airborne delays due to arrival capacity limitations linked to wake separations
    - For the major airport that are today constrained in peak hours, the use of optimised wake category scheme or pairwise separations can either be translated into added capacity (as described above) or additional resilience in case of perturbation.
    - This has been independently quantified by the French STAC (Service Technique de l'Aviation Civile) for CDG using 6 categories scheme for a test case: LVP condition imposed during the morning peak.
      - 20% reduction of recovery time (time to come-back to nominal planning)
      - 12% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)
  - For the major airport that are today capacity constrained in peak hours, the use of time based separation will enable a reduction of a minimum of 50% of delay induced by headwind, which is a major source of European network delay (P681 VALR).
  - On less constrained airports, significant improvement can also be observed by employing reduced separation applied on a time based separation basis in the specific runway configuration or wind conditions responsible for a large part of the airport delay.
  - Increase in the flexibility for Controllers to manage the arrival traffic due to the separation minima reduction

- **Reduced TBS as function of weather conditions (WDS + TBS) - AO0310 and AO0304 and AO-0303**
  - The application of weather dependent separations (WDS) through a reduction or a suspension of the time based wake turbulence separations, over the duration of identified and stable forecast weather conditions, that either ensures transport of the wake turbulence out of the path of the follower aircraft, or ensures decay of the wake turbulence so that it is no longer a hazard to the follower aircraft for:
  - departures from the runway for the initial common departure path,
  - arrivals on final approach,

  - Taking into account any meteorological conditions (e.g. crosswind), integrated with system support for separation delivery, RECAT EU / RECAT 2 / Optimised Categories and TBS.
  - Development of advanced departure procedures based on wind conditions will allow the follower departure aircraft to avoid the wake generated by the departure aircraft in front on the same runway by employing an earlier rotation position and a steeper initial climb path.
  - The objective is to enable a tactical increase in the arrival and departure achieved capacity in favourable weather conditions so as to more efficiently deal with the fluctuations in the arrival and departure demand with a positive effect on runway queuing related delays.
- <u>Capacity</u>:
  - Expected runway throughput increase as a function of traffic mix and weather conditions.

    The increase of arrival capacity will be directly proportional to the proportion of wake constrained pair in the peak hours. In case of favourable crosswind conditions the expected benefit can be quantified as followed (A380 not considered):

    - An increase of 5% runway throughput for 10% Heavy* in the traffic mix
    - An increase of 10% runway throughput for 20% Heavy* in the traffic mix
    - An increase of 20% runway throughput for 50% Heavy* in the traffic mix
    - An increase of 30% runway throughput for 80% Heavy* in the traffic mix

    With 10% A380 in the traffic mix

    - An increase of 10% runway throughput for 10% Heavy* in the traffic mix
    - An increase of 20% runway throughput for 30% Heavy* in the traffic mix
    - An increase of 30% runway throughput for 60% Heavy* in the traffic mix

    *Heavy wake category aircraft
- <u>Operational Efficiency</u>:
  - The increase throughput being dependent on the observed weather conditions, the actual increase of airport capacity will depend on the frequency favourable conditions are observed, and hence why the substantial runway throughput described above should be predominantly used for reabsorbing delay. It is important to note that this solution is in addition to the concepts permanently applied like TBS or PWS. EUROBEN study has however shown that the condition for using reduced separation thanks to crosswind can be very frequent at some airports. The weather dependant reduction of wake separation, considering the allowable increase of throughput, is expected to be a major mitigation of delay and to provide for an increase in the flexibility for Controllers to manage the arrival traffic due to the reduction in the required wake separations.

    Using similar approach as the one developed by the French STAC (Service Technique de l'Aviation Civile) for CDG, the use of weather dependant reduction for a test case: LVP condition imposed during the morning peak has shown a reduction.
  - 30% reduction of recovery time (time to come-back to nominal planning)
  - 20% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)

- **Decay enhancement devices as safety improvement and/or booster of WDS / RECAT-2 effect – AO-0325**
  - The installation of decay enhancing devices at the runway tails, so-called plate lines, in order to accelerate wake vortex decay in ground proximity, i.e. the flight phase with most reported encounters. These devices shall increase flight safety and capacity gains to be achieved by the RECAT-EU/RECAT-2 matrix and weather dependent separations (WDS). For this purpose the compatibility with airport requirements and the technical realisation shall be elaborated. Comprehensive validation at a suitable major airport (e.g. with Lidar and/or 3D Radar). It would lead to further optimisation of RECAT-EU/RECAT-2 matrix and WDS considering the beneficial effects of the decay enhancing devices.
- Safety:
  - Reduction of the maximum WV life time by 20% leading to a positive impact on wake encounter rate close to ground and hence creating an associated safety benefit.
- **Wake monitoring as safety improvement– AO-0327**

  Ground based or airborne wake turbulence prediction/detection will improve operation safety by providing with better awareness of wake turbulence risk. The airborne function could also be useful in other flight phases (en-route for example).

  This monitoring could also be alternative options (complementing regular reporting scheme) to provide with efficient and objective inputs for wake vortex encounter risk monitoring as recommended by EC Regulation No 1035/2011 “Common Requirements”, Annex II and technically specified in RECAT-EU safety case report. Wake Turbulence risk monitoring activity shall be conducted at places where RECAT scheme will be deployed and applied in operation (reporting, ground or airborne monitoring).

SOLUTION PJ.02-02 Enhanced arrival procedures

- Capacity:
  - Capacity aspect is currently being assessed within SESAR project 6.8.8. Quantitative assessment is dependent on the airport topology. That said depending on the platform, it is expected that having low noise procedure will allow to remove the curfew and to allow additional slots. Similarly, optimizing runway aiming point will also optimize runway occupancy. Multiple runway aiming points can serve as an enabler for reducing wake turbulence separations as well as reducing the wake vortex encounter risk.
- Environmental Sustainability:
  - A-IGS and IGS will allow a reduction of noise footprint on ground below final approach segment Double slope operations enable noise reduction over sensitive areas by flying higher for longer, thus benefiting from gain of height (increasing noise distance propagation).
  - Early study have shown a local benefit -3dbAmax on a -4° slope (compared to a -3° GS). A -3.5° A-IGS approach could reduce noise from 1.5dBAmax in the stabilized part of the trajectory (below 1000 ft.); 1 to 3 dBAmax benefit in the last.
  - MRAP brings important noise benefits close to the airport as the noise footprint is

shifted accordingly.

SOLUTION PJ.02-03 Minimum-Pair separations based on RSP

- Capacity:
    - Expected runway throughput increase up to 20% mainly for arrival (depending on traffic mix) during peak periods, at constrained airports
    - The increase of capacity will be directly proportional to the proportion of NON-wake constrained pair (without Heavy in front) in the peak hours.
    - This will be particularly efficient for[5]
        - Congested secondary airport with limited number of Heavy (<10% in peak) like: Munich, Copenhagen, Oslo, Stockholm, Barcelona, Palma de Mallorca, Vienna, Brussels…
    - congested major airport during traffic peak with limited number of Heavy, typically afternoon peak of: Frankfort, Amsterdam, Roma, Zurich
    - The expected benefit can be quantified as followed (A380 not considered) :
        - An increase of 25% runway throughput for 0% Heavy in the traffic mix
        - An increase of 20% runway throughput for 10% Heavy in the traffic mix
        - An increase of 15% runway throughput for 30% Heavy in the traffic mix
        - An increase of 10% runway throughput for 50% Heavy in the traffic mix
    - With 10% A380 in the traffic mix
        - An increase of 20% runway throughput for 0% Heavy in the traffic mix
        - An increase of 15% runway throughput for 20% Heavy in the traffic mix
        - An increase of 10% runway throughput for 40% Heavy in the traffic mix
- Operational Efficiency and Resilience:
    - Reduction of airborne delays due to arrival capacity limitations linked to MINIMUM RADAR SEP.
        - For the airport that are today constrained in peak hours, the use of reduced minimum radar separations to 2Nm can either be translated into added capacity (as described above) or additional resilience in case of perturbation.
        - Using similar approach as the one developed by the French STAC (Service Technique de l'Aviation Civile) for RECAT-EU in CDG, the use of reduced MRS for a test case: LVP condition imposed during the morning peak has shown a reduction
        - 50% reduction of recovery time (time to come-back to nominal planning)
        - 30% Reduction of cumulative delay (sum of minute of delay for all aircraft before recovery)
    - Increase flexibility for Controllers to manage the arrival traffic due to the separation minima reduction Resilience would further benefits of the above mentioned goals

SOLUTION PJ.02-05 Independent Rotorcraft operations at the Airport

- Access & Equity

    - Improved accessibility at airports

- Airport capacity

    - Removing rotorcraft operations from the runway will provide benefits in runway

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[5] *CFUM data 2014*

throughput

- Operational efficiency
- Environmental impact
    - Reduced impact
- Costs
    - Reduced costs
- Interoperability
    - The solution may have impact on Interoperability as it needs to be interoperable with surface movement and gate allocation for flights currently not allowed to operate in adverse weather conditions at the airport, and for sequencing and merging in APP to be integrated with IFR flights.

SOLUTION PJ.02-06 Improved access into secondary airports in low visibility conditions

- Capacity:
    - Expected major airport capacity increase by 3 to 5% by allowing the use of secondary airport in LVP.
- Safety:
    - Increase of safety associated with increased awareness for the pilot.
- Flexibility:
    - At secondary airports 15% increase of traffic capable with operating in LVP.

SOLUTION PJ.02-08 Traffic optimisation on single and multiple runway airports

- Capacity:
    - Detect Demand & Capacity imbalances during the Medium /Short Term planning can increase runway throughput up to 10-15% depending on the airport layout, traffic mix and weather conditions.
    - For airports constrained at peak hours, the use of the optimum runway configuration can either be translated into added capacity (reducing lost slots) or additional resilience in case of perturbation.
    - The use of new PWS and predicted ROT will allow removing operation buffers providing additional slots.
- Predictability:
    - A more realistic and precise accuracy on landing and departure times will increase predictability allowing airspace users to better planning of the ATV avoiding passengers delays and cancelations during the execution phase.
- Efficiency:
    - Imbalances known more than 3 hours ahead allow to re-planning inbound traffic in the origin airport or reconsider ATV on behalf of airlines reducing delays due to airport constraints up to 20%.
    - It is expected that planning runway closures or runway changes along the day in the optimum periods will minimize the time spent re-routing air and ground traffic during

    - the execution phase. Sharing this information with the different actors allow to provide NOP with more accurate forecasted times for arrivals and departures in order to coordinate the consequent target times.
    - Reduction of airborne delays due to a planned arrival capacity limitations has a direct impact on fuel costs and emissions
- Safety:
    - Increasing runway throughput in terms of 10-15% and increasing capacity regarding recovery of lost slots will lead to an associated improvement in safety so that the total number of ATM-induced accidents and serious or risk bearing incidents would not increase despite traffic growth;
- Human Performances:
    - Considering the current maturity level of the proposed solution, it is expected a quantitative effect on Human performances due to a more efficient operation derived from better forecasted situation avoiding the Supervisor and ATCOs answering in a reactive manner.

SOLUTION PJ.02-09 Enhanced Runway Condition Awareness

- Safety:
    - Inconsistency with actual aircraft braking performance is the main shortcoming of conventional reporting means of runway condition. Runway found more slippery than reported by flight crews is a common contributing factor to runway excursions. The deployment of aircraft sensed runway slipperiness should enable to connect runway condition reporting with actual aircraft braking performance and mitigate runway excursion risks which is the highest accident / incident exposure (IATA Safety Report 2014).
    - The non-intrusivity of proposed methods will enable to enhance significantly the measuring rate of runway condition during winter operations (e.g. at least 20 times when using aircraft sensed data).
    - Modelling of runway condition is significantly improving the quality of information presented to the crew before runway operation.
- Capacity:
    - Real-time and non-intrusive update of Runway Condition information through accurate knowledge of current and predictive aircraft braking performance should enable to avoid runway closures for friction measurements (20-30mn per closure) and potentially induced delays due to unavailability of the runway.
    - Modelled data improved by the information received from on-board systems will improve planning of runway use and will provide most precise information for capacity planning.
    - Proposed methods will enable state-of-the-art predictability of runway conditions which are considered vital for improvements of AMAN / DMAN calculations at congested airports.
- Resilience:
    - The methods proposed in the PJ.02-09 offer a better resolution than conventional tools to assess runway condition. These methods are expected to enable airports to maintain normal operation conditions for a longer time period before having to revert to degraded operation conditions (runway closures, reversion to operations on the longest runway only both for departures and landings, etc.).

SOLUTION PJ.02-11 Enhanced Terminal Area for efficient curved operation

- Human performances:
    - Considering the current maturity level of the proposed solution, quantitative prediction of the effect cannot reasonably be provided. That said Human performances are expected to be considerably alleviated as the restructuration of TMA will allow more efficient operation (flow segregation and in term of approach design as this will allow shorter final segment and so later turn). The procedure will be designed from the entry into the TMA down to the runway (even down to Cat II/III operation).

Need for coordination at European/Global level

LOCAL: *The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;*

NETWORK: *The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).*

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.02-01 **Wake Turbulence Separations Optimization**	L	The solution doesn't require a synchronised deployment with multiple stakeholders. Strictly speaking, it doesn't require for being operated EU-wide multi-stakeholders standard neither since the solution will be primary local solution. However, development of a common EU standard or Specification with the safety evidence and generic safety case to support the local safety case may really facilitate these local deployments. The glideslope wind conditions profile can be derived from the already mandated Enhanced Mode S airborne parameters from the arrival aircraft flying the final approach glideslope. The use of broadcasted MET information (as used for TBS at Heathrow) but also possibly (even if not currently mandated) of downlinked landing stabilisation speed intent by equipped aircraft may need interoperability and equipment to be deployed; however this will just be considered as one of the option for Solution PJ.02-01 that can also be used if available. This means that the Solution PJ.02-01 remain a local solution. The full use of broadcasted information from the aircraft will be considered in Solution 10 (Wave2) that will require full interoperability.
SOLUTION PJ.02-02 **Enhanced arrival procedures**	N	The deployment of enhanced arrival procedures requires the GBAS ground system deployed in the airport, the GBAS capability available on board and therefore some synchronisation Air-Ground navaid. Similarly SBAS procedure should be deployed and Aircraft equipped.

SOLUTION PJ.02-03 **Minimum-Pair separations based on RSP**	L	No synchronization required between A/G deployments. Coordination shall be provided to develop EU standards: The application of the 2NM MRS is a local decision. The RSP and associated restrictions should be coordinated globally as per the current 2.5NM MRS.
SOLUTION PJ.02-05 **Independent Rotorcraft operations at the Airport**	N	Even if the procedures would require local coordination depending on the enabler there could be the need of air ground synchronization deployment
SOLUTION PJ.02-06 **Improved access into secondary airports in low visibility conditions**	N	Inclusion of different sensors and observations provides network – wide opportunity for improve the accessibility of small airports. Air/ground – ground synchronized deployment is required
SOLUTION PJ.02-08 **Traffic optimisation on single and multiple runway airports**	L	No air ground synchronization deployment is expected
SOLUTION PJ.02-09 **Enhanced Runway Condition Awareness**	N	Solution improves airports operating environment. Data provided to ATC (TWR, APP) and systems will be used for provision of efficient and safe operations. A/G coordination is required for synchronized deployment
SOLUTION PJ.02-11 Enhanced Terminal Area for efficient curved operation	N	The deployment of enhanced arrival procedures requires the redesign of TMA based on GBAS ground system deployed in the airport, and/or SBAS augmentation and therefore some synchronisation Air-Ground navaid, GBAS and SBAS procedure as well as Aircraft capability are required.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.02-01 Wake Turbulence Separations Optimization

- SESAR 1 P06.08.01-D30 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED
- SESAR 1 P06.08.01-D32 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 SPR
- SESAR 1 P06.08.01-D34 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 Interop
- SESAR 1 P06.08.01 Phase 1 and Phase 2 VALRs
- SESAR 1 P10.08.01-D02 Step 1 system requirements
- SESAR 1 P10.08.01-D18 Step 2 final Technical Specification
- SESAR 1 P10.04.04-D18 System Requirements finalized
- SESAR 1 P09.11-D26 WEPS Concept of Operations and Requirements
- SESAR 1 P09.30-D11 LiDAR sensor requirements and technology selections for wake alleviation by flight control
- SESAR1 P12.02.02 - D56: Updated TS for TBS PW separation ORD and WDS Arrival

Solution PJ.02-02 Enhanced arrival procedures

- SESAR 1 P06.08.08-D02 Enhanced Arrival Procedures Enabled by GBAS – Applicable regulatory Framework
- SESAR 1 P06.08.08-D07 Enhanced Arrival Procedures Enabled by GBAS - OSED Consolidation
- SESAR 1 P06.08.08-D04 Enhanced Arrival Procedures Enabled by GBAS - SPR – Consolidation
- SESAR 1 P06.08.08-D05 Enhanced Arrival Procedures Enabled by GBAS - INTEROP – Consolidation
- SESAR 1 P06.08.08 D11 Enhanced Arrival Procedure Enabled by GBAS - VALR - V3
- SESAR 1 P06.08.05-D04 OSED Displaced Thresholds
- SESAR 1 P06.08.05-D55 Approach Procedures Charts and Path Terminators for RNP transition to GLS and Displaced Thresholds
- SESAR 1 P06.08.05-D44 Concept Validation Report for Advanced Procedures (DT concept) for V2
- SESAR 1 P06.08.05-D42 Concept of GBAS Advanced Operations Document (OSED- V3)

Solution PJ.02-03 Minimum-Pair separations based on RSP

- SESAR 1 P06.08.03 D23 S2 V1 OSED- Report
- SESAR 1 P06.08.03 D24 S2 V1 Interoperability Requirements
- SESAR 1 P06.08.03 D04 S1 V1 SPR - Report
- SESAR 1 P06.08.01-D30 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 OSED
- SESAR 1 P06.08.01-D32 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 SPR
- SESAR 1 P06.08.01-D34 OFA 01.03.01 Enhanced Runway Throughput Consolidated Final Step 1 Interop
- SESAR 1 P06.08.01 Phase 1 and Phase 2 VALRs
- SESAR 1 P06.08.01-D56 VALR

Solution PJ.02-05 Independent Rotorcraft operations at the Airport

- SESAR 1 P04.10-D11 Final Operational Services and Environment Description
- SESAR 1 P04.10-D06 Validation Report – Iteration 1
- SESAR 1 P04.10-D09 Validation Report – Iteration 2

Solution PJ.02-06 Improved access into secondary airports in low visibility conditions

- SESAR 1 OFA 01.01.01 OSED, SPR, INTEROP
- SESAR 1 P06.08.05 OSED
- SESAR 1 P06.08.05 D14 "Concept Validation Plan for GBAS CAT II/III"
- SESAR 1 P06.08.05 D15 "Concept Validation Report for GBAS CAT II/III"
- SESAR 1 P06.08.08-D07 Enhanced Arrival Procedures Enabled by GBAS - OSED Consolidation
- SESAR 1 P06.08.08-D04 Enhanced Arrival Procedures Enabled by GBAS - SPR – Consolidation
- SESAR 1 P06.08.08-D05 Enhanced Arrival Procedures Enabled by GBAS - INTEROP – Consolidation

Solution PJ.02-08 Traffic optimisation on single and multiple runway airports

- SESAR 1 OFA 04.02.01 OSED, SPR, INTEROP

- SESAR 1OFA 04.01.01 OSED, SPR, INTEROP
- SESAR 1 OFA 04.01.02 OSED, SPR, INTEROP
- SESAR 1 OFA 05.01.01 OSED, SPR, INTEROP
- SESAR 1 OFA 05.06.04 OSED, SPR, INTEROP
- SESAR 1 12.02.01 OUTCOMES

Solution PJ.02-09 Enhanced Runway Condition Awareness

- SESAR 1 OFA 05.06.04 OSED, SPR, INTEROP
- SESAR 1 12.07.05 OUTCOMES

SOLUTION PJ.02-11 Enhanced Terminal Area for efficient curved operation

- SESAR 1 P06.08.05-D42 Concept of GBAS Advanced Operations Document (OSED- V3)
- SESAR 1 P06.08.08-D07 Enhanced Arrival Procedures Enabled by GBAS - OSED Consolidation
- SESAR 1 P06.08.08-D04 Enhanced Arrival Procedures Enabled by GBAS - SPR – Consolidation
- SESAR 1 P06.08.08-D05 Enhanced Arrival Procedures Enabled by GBAS - INTEROP – Consolidation
- SESAR 1 P06.08.08 D11 Enhanced Arrival Procedure Enabled by GBAS - VALR - V3.

Dependencies

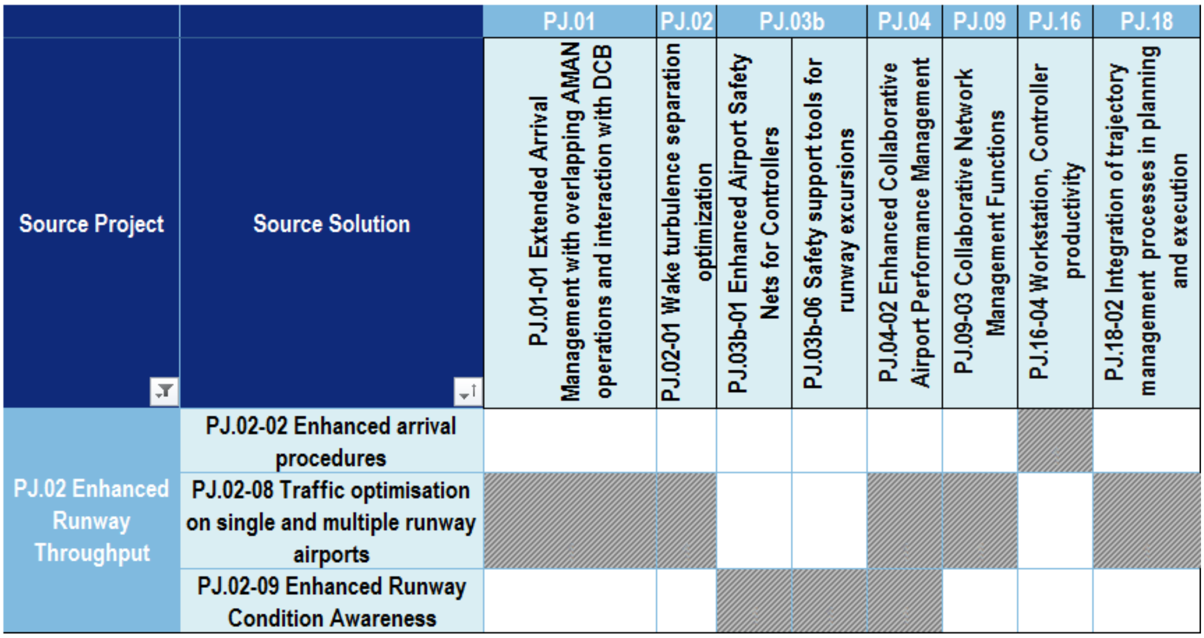
Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as *Source Solutions* are required as an input for the success of this project and its solutions:

		PJ.02						
Source Project	Source Solution	PJ.02-01 Wake turbulence separation optimization	PJ.02-02 Enhanced arrival procedures	PJ.02-05 Independent Rotorcraft IFR operations at the Airport	PJ.02-06 Improved access into secondary airports in low visibility conditions	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.02-09 Enhanced Runway Condition Awareness	PJ.02-11 Enhanced Terminal Area for efficient curved operation
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB					▨		
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	▨				▨		
	PJ.01-03 Dynamic and Enhanced Routes and Airspace							▨
PJ.02 Enhanced Runway Throughput	PJ.02-08 Traffic optimisation on single and multiple runway airports	▨						
PJ.03a Integrated Surface Management	PJ.03a-04 Enhanced Visual Operations				▨			
PJ.03b Airport Safety Nets	PJ.03b-01 Enhanced Airport Safety Nets for Controllers					▨		
	PJ.03b-03 Conformance monitoring safety net for Pilots					▨		
PJ.04 Total Airport Management	PJ.04-02 Enhanced Collaborative Airport Performance Management					▨		
PJ.07 Optimised Airspace Users Operations	PJ.07-02 AU Fleet Prioritization and Preferences					▨		
PJ.13 Air Vehicle Systems	PJ.13-02-02 GA/R Specific Navigation Systems		▨	▨				
	PJ.13-02-03 GA/R Specific Surveillance Systems			▨				
PJ.14 CNS	PJ.14-03-01 GBAS		▨	▨				▨
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity		▨			▨		
PJ.17 SWIM Infrastructures	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing						▨	
PJ.18 4D Trajectory Management	PJ.18-02 Integration of trajectory management processes in planning and execution					▨		
SESAR1	#09 Enhanced terminal operations with automatic RNP transition to ILS/GLS		▨					▨
	#15 Integrated and throughput-optimised sequence of arrivals and departures					▨		
	#40 Wake Turbulence Separations based on Static Aircraft Characteristics for Arrivals	▨						
	#46 Initial SWIM	▨	▨		▨	▨	▨	

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.



		PJ.01	PJ.02	PJ.03b		PJ.04	PJ.09	PJ.16	PJ.18
Source Project	Source Solution	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB	PJ.02-01 Wake turbulence separation optimization	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.03b-06 Safety support tools for runway excursions	PJ.04-02 Enhanced Collaborative Airport Performance Management	PJ.09-03 Collaborative Network Management Functions	PJ.16-04 Workstation, Controller productivity	PJ.18-02 Integration of trajectory management processes in planning and execution
PJ.02 Enhanced Runway Throughput	PJ.02-02 Enhanced arrival procedures							▨	
	PJ.02-08 Traffic optimisation on single and multiple runway airports	▨	▨			▨	▨		▨
	PJ.02-09 Enhanced Runway Condition Awareness			▨	▨	▨			

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

- FP7 UFO project (Solution PJ.02-01)
- STCA adapted for Pairwise Separation Based on Required Surveillance Performance (Solution PJ.02-03)
- ICAO Wake Turbulence Study Group and EU Wake Vortex Task Force
- EASA
- ICAO and Eurocontrol/FAA IGWG (International GBAS Working Group)
- DLR Project L-bows (Land-based and on-board wake systems)
- ICM Project PROZA (Solution PJ.02-09)

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently applicable standards and regulations are applicable to the work in this project. In particular:

- Wake turbulence separation minima – ICAO
- Current radar separation minima – ICAO
- UK TB and DB WV Separations for Arrivals and Departures
- ED-87B Amd 1 - Minimum Aviation System Performance Specification for Advanced Surface Movement Guidance and Control Systems (A-SMGCS), 01 January 2009 ICAO 9368 Instrument Flight Procedures Construction Manual
- Amendment 11 to Annex 14, Volume I – ICAO
- Annex 6 & PANS OPS (aeroplane performance operating on dry, wet and contaminated runways, common taxonomy and definition – ICAO
- Annex 15 : Change to SNOWTAM – ICAO
- TALPA-ARC Recommendations

Identification of on-going standardization and regulatory activities where the project should contribute to e.g. active EUROCAE working groups e.g. WG-78

- ICAO FTF Step 2 and future Step 3
- ICAO NSP and IFPP
- EUROCAE WG-28 (GNSS) and WG-62 (Galileo)
- EUROCAE WG-41 (SMGCS) and similar RTCA group
- New wake turbulence separation minima re-categorization
- RECAT EU, TBS @ Heathrow, RECAT 2 (Arrivals)
- SAE G-10WV wake vortex committee (airborne wake vortex safety systems)
- RTCA wake vortex tiger team
- EUROCAE WG-76 Aeronautical Information and Meteorological Management
- EUROCAE WG28, 62
- RTCA SC159

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (Airport, TMA),
    - ATM Operational Experience (Airport, TMA),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - Meteorological and wake vortex physics
    - MET expertise,
    - AIM expertise.
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - A/G RF Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.2 High Performing Airport Operations – Integrated Surface Management (PJ03a)

PJ.03a	Integrated Surface Management

Problem Statement

Following on from developments in SESAR 1, current airport infrastructures and services provided to Airport Stakeholders need to be optimised further to support the expected increase in traffic and prevent a negative impact on the performances of the overall Air Traffic Management (ATM) network. With increases in traffic, airports and airlines need to enhance their abilities to deliver, plan and improve the use of airport resource allocation so that costs, emissions and fuel use can be reduced, whilst improving passenger satisfaction. Further integration of ATC tools through Surface Management with other systems could enable this.

While many large Airports have introduced varying Airport Collaborative Decision Making (A-CDM) tools (AOP/APOC) and processes, there is still some isolation between stakeholders and their influences on the overall airport performance and allocation of resources. Equally the process is not end to end, and the delivery from Stand to Runway or Runway to stand could be further optimised through enhanced and integrated Surface management. Even though some work has been done during SESAR 1, arrival and departure planning systems are not yet fully taking advantage of advanced surface management functions or providing optimisations, so the controller is required to manage these separate processes with less ability to react to unknown variances which result in non-optimal delivery.

While in SESAR 1 work has been undertaken on taxi Route planning and sharing, the airport planning tools act as disjunctive systems: Arrival and Departure Managers (AMAN/DMAN) are not fully integrated with the advanced surface management and airport operations management functions. The low level of reliability and predictability of the taxi times and the lack of information sharing among these systems have a negative impact on the smoothness of the traffic flow especially in airports with mixed mode runways. This also prevents ATCOs from optimising the surface management and ensuring delivery to plan. In addition, it is also important to guarantee that the data sharing among the different stakeholders, including systems like AMAN and DMAN, is carried out in a “secure mode” with proper cyber security system architecture in order to avoid any malicious attacks which could impair airport operations and passenger safety.

Not all relevant SESAR 1 concepts will have reached V3 maturity; this limits the benefits of the SESAR 1 airport operations management concept, as predictable/variable taxi times are essential inputs for the efficiency and predictability of the turnaround process at the airport. The ability to adapt to unknown or unplanned constraints is limited. Combined use of AGL, and/or direct control of taxi speed, including virtual stop-bars, could enable better delivery to plan and enhanced safety and needs to be further developed from the work on individual solutions performed in SESAR 1.

Inefficient planning and delivery of movements on the airport leads to inaccuracies in the prediction of taxi times, leading to a limitation of airport capacity (available resources underutilised).

In order for Aircraft to better plan their taxi-in and taxi-out phases, using either single engine or a form of automatic taxi, the DMAN, AOP, A-SMGCS and AMAN need to be integrated and any changes in routing made available to the aircraft, in order to adjust the plan. Present engine-off taxi procedures can cause congestion or delays due to uncertainty about sequence and routing, with no optimal run up times.

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.

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 radio transmitter (R/T). Further integration of datalink taxi clearances (D-Taxi), Airfield Ground Lighting (AGL), flight-deck and vehicle systems needs to be enabled to remove this constraint. Low visibility and increased traffic volume make navigation and collision avoidance even more complicated and safety critical. Under such adverse conditions, pilots have to rely almost entirely on the information and instructions provided by the controller, who has the overall view of the traffic situation on his/her display. In addition, the use of block control procedures implies an increase in voice communication impacting also the controller's workload and stress burden and, when A-SMGCS can be used, it still contains restrictions and limitations and isn't a shared picture. For safety purposes, capacity is significantly reduced so as to limit the number of mobiles operating at a given time on the airport surface. The need to reduce voice communication and ATCO workload leads to the necessity to rely on digital communications which entails to strengthen the communication infrastructure solution by an embedded security solution. This one can well support the integrated surface functionalities as well as SWIM users' authentication and, in the meantime, guarantee an appropriate level of robustness to any intentional attacks. This solution will have an indirect benefit on workload saving as well.

Moreover, low visibility conditions impact negatively vehicle drivers as well with consequence of reducing their situational awareness in the aerodrome overall picture.

In this context the use of Enhanced Vision System (EVS) and Synthetic Vision System (SVS) is an opportunity, but appropriate ATC procedures are required in order to make ATCOs, pilots and vehicle drivers able to manage safely operations using these technologies.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

In SESAR 2020, PJ.03a 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 (PJ.04) will be improved.

The exchange of information between ATC and vehicles/aircrafts will be improved with the use of airport data link and other guidance means. The procedures for the surface traffic management need to be validated with the new systems (**Solution PJ.03a-01**).

The project will investigate the exchange of virtual stop bar identifier and status between ATCOs and flight crews to improve safety in low visibility conditions (**Solution PJ.03a-01**).

Furthermore, to improve reliability and predictability of taxi times and milestones of planning information, integration issues of OIs already developed in SESAR 1 (AO-0205, TS-0203, TS-0309, AO-0803, DCB-0309, AUO-0308 (D-TAXI), AUO-0603-A (AGL), AO-0206, AO-0215, AO-0222 and/or AO-0223 etc.) will be addressed.

PJ.03a is expected to contribute to the definition and evaluation of advanced aircraft automated systems. The integration with future ATC surveillance systems is also expected for surface operations (**Solution PJ.03a-03**).

In **Solution PJ.03a-03**, Global Navigation Satellite System (GNSS) augmented system can be used to improve the accuracy of aircraft navigation (position, speed and time) in both surface movement and take-off/landing operations. The augmented aircraft position, shown on the on-board navigation display, allows minimising the impact of bad weather on surface operations. Inside the GNSS augmented system, a secure Ground-Based Augmentation System (GBAS) solution, through the integration of “safety-of-life” / Public Regulated Service (PRS) receivers in the GBAS Ground Station in order to improve the accuracy of aircraft (a/c) navigation. This topic needs to be considered at the application level.

Solution PJ.03a-04 works on Enhanced Vision System (EVS) and Synthetic Vision System (SVS), which concepts will be developed to enable more efficient taxi, take-off and landing operations in low visibility conditions. This is applicable to all platforms and, even if main airline platforms have auto-land capabilities to facilitate approaches in low visibility conditions, they have no capabilities to facilitate taxi and take-off in order to maintain airport capacity. Access into small airports in low visibility conditions will also be improved, as these airports are generally not equipped with systems enabling auto-land, and most of the time will not be equipped with GBAS ground stations. The initial goal for airlines 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.

For Business Aviation the goal is to maximize the benefits offered by SBAS/LPV, EVS and SVS (either head up or head down) to allow access to small airports in close to CAT II, CAT III visibility conditions. Work will address taxi, take-off and landing operations.

The operational flight safety benefits are an important aspect of EVS and SVS systems, e.g., landing, taxi and take-off in low ceiling/RVR conditions.

The graphic concepts that will be used integrate visualizations based on correlation of enhanced vision sensor and database information. The EVS sensor selection activity work should be common to both the Head-Down Display (HDD) and Head-Up Display (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. To realize real-time simulations in this field it is necessary to prepare on-board sensor-simulation tools, which deliver images and/or data like long wave infrared (LWIR), short wave infrared (SWIR), LIDAR and active RADAR. Only the proper integration of these tools into the whole simulation chain will support the validation of concepts of low visibility taxi assistance before attaching systems to real aircraft. The work includes the definition of procedures and sensors, data bases, data link, display hardware, symbology overlay, navigation solutions, additional weather information, human factors concepts that will demonstrate the system value for more efficient taxi, take-off and landing operations in low visibility conditions.

The project shall also address the operational concept differences to enable the safe integration of General Aviation (GA), Rotorcraft and civil Remotely Piloted Aircraft Systems (RPAS).

GA and Rotorcraft

Many GA aircraft and rotorcraft are equipped to operate in poor weather conditions. The project will identify any requirements that are specific to GA and rotorcraft, and coordinate with PJ.13. Where appropriate prototypes will be developed.

RPAS

As RPAS enter service, their ability to operate on an airport surface alongside manned platforms will become increasingly important. The project will examine the particular requirements of remotely piloted operations, and describe the differences from manned operations, providing operational requirements for technological developments that could mitigate those differences.

PJ.03a should investigate interoperability with the ATM Systems, and the integrity, confidentiality and trustworthiness concerning the data exchange and the procedures during the remote control phase between the air vehicle and the Ground based system.

Finally PJ.03a shall consider for all the identified solutions the analysis and development of pilots’, vehicle drivers’ and controllers’ working methods and operational procedures in order to assure that the responsibilities for each are unambiguous. All involved actors shall clearly be instructed about their capability and their area of responsibility.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.03a-01: Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing

This solution 1 aims at providing complete enhanced guidance assistance to flight crews, vehicle drivers and controllers on the airport. It will build upon and further enhance and integrate the various developments from SESAR 1.

This solution is composed of several airborne and ground functions and aims at :

- Providing a display of the airport layout, dynamic traffic context information, taxiways, runways, fixed obstacles, own aircraft position, the route (to runway or stand), with taxi clearances (as issued by ATC) to the flight crew. It will also be clarified whether the possibility for a manual input of the route and an uplinked one should coexist.
- Showing the status of runways and taxiways with the integration and synchronisation of Virtual Stop Bar (VSB) identifiers and status between the ATCOs, A-SMGCS display and the flight crew’s display.
- Integrating AGL solutions (e.g. “follow the greens”) with the new information (previous items) available in the cockpit.
- Providing ground vehicle drivers (any ground vehicles including also taxi-bots) with traffic situation awareness, including on-board display of airport layout, dynamic traffic context information, taxiways, runways, fixed obstacles, own vehicle position, vehicle clearances and routes as issued by ATC.

The A-SMGCS routing function is extended to avoid potential traffic conflicts. Improvements can be made in the use of AMAN and DMAN information and the integration with Total Airport Management procedures. To this end, a prediction capability identifying bottlenecks and hotspots on the taxiways, aprons and runways (the latter if the airport layout requires taxiing aircraft to cross a runway) is required. The resulting information will provide the input for an effective routing and scheduling optimization algorithm in order to improve route planning and prevent potential conflicts.

The ATCO’s Human Machine Interface (HMI), i.e. the Advanced Controller Working Position (A-CWP), is extended with sufficient means to interact with the routing and scheduling optimization algorithm and subsequently transmit routes, clearances, etc. to the flight deck via data link, AGL or voice).

Integration of these systems, definition & validation of procedures, and interoperability between ATC and A/C systems is part of this solution.

The end result is to contribute to:

- Increase a common situational awareness between the ATCOs, the flight crew with (air-ground & ground) data-link exchanges including AGL-based guidance and vehicle driver through (ground) mobile airport communication exchanges.
- Increase efficiency, in particular utilising D-Taxi, AGL, VSB etc., reducing both ATC and cockpit workload and R/T. Optimised conflict-avoiding route proposals should reduce ATCO workload.
- Improve safety in low visibility conditions.
- Manage security credentials for aircraft and ground vehicles so as to operate with secure air-ground data-link and secure (ground) mobile airport communication exchanges.

This solution is tightly linked with other solutions developed in PJ.03a. Indeed Solution PJ.03a-01 will take advantage of the availability of new data information resulting from new CDM processes (integration of trajectory management and new terminal information). All of those new sources of data will contribute to better situation awareness shared between ATCOs and the flight crew.

The Airport Surface Safety Net (PJ.03b Solution 01) detects any aircraft deviation to the route cleared by the controller and shall interact with this PJ.03a solution in order to ensure that appropriate guidance information is provided to the flight deck. Strong coordination with PJ.03b will be required for PJ03a-01.

List of OI Steps & Enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.03a-01
Enhanced Guidance Assistance to Aircraft and Vehicles on the Airport Surface Combined with Routing</th><th colspan="5">MATURITY</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>AUO-0603-B “Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing in Step 2”
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-42c</td><td>Onboard management of dynamic update of runway/taxiway status</td></tr></table></td><td>V2</td><td>V2</td><td></td><td>V3</td><td></td></tr>
</table>

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<td>
<p>AO-0206 “Enhanced Guidance Assistance to Airport Vehicle Driver Combined with Routing”</p>
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-30</td><td>Use of airport wireless communication infrastructure for mobile data'</td></tr>
<tr><td>AIRPORT-44</td><td>Onboard vehicle display for taxi information and clearances, using common airport map database</td></tr>
<tr><td>CTE-C02b</td><td>A/G Datalink over ATN/OSI - Single frequency</td></tr>
<tr><td>CTE-C02d</td><td>New Airport Datalink technology (AEROMACS)</td></tr>
<tr><td>CTE-C02e</td><td>New A/G datalink using ATN/IPS over L-band</td></tr>
<tr><td>CTE-C02f</td><td>Future Satcom for ATM- P15.2.5 Precursor for SBB</td></tr>
<tr><td>CTE-C02h</td><td>Future Satcom for ATM- P15.2.6/IRIS</td></tr>
<tr><td>CTE-C03a</td><td>Commercial wireless technologies at the Airport surface</td></tr>
<tr><td>CTE-C03b</td><td>Broadband Satcom Datalink (i.e. Global Express)</td></tr>
<tr><td>CTE-C04</td><td>Future Communication Infrastructure - ATN/IPS and Multilink</td></tr>
<tr><td>CTE-S03</td><td>ADS-B Receiving Station</td></tr>
<tr><td>CTE-S03f</td><td>New ADS-B receiver for vehicles</td></tr>
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<td>V2</td><td></td><td></td><td>V3</td><td></td>
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<td>
<p>AO-0215 “Airport ATC provision of ground-related clearances and information to vehicle drivers via datalink”</p>
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-14</td><td>Surface movement management tools updated to provide ground clearances and information to the vehicle driver</td></tr>
<tr><td>AERODROME-ATC-50</td><td>Advanced Controller Working Position (A-CWP) supporting A-SMGCS functionalities</td></tr>
<tr><td>AIRPORT-01</td><td>In-vehicle access to ground clearances and information</td></tr>
<tr><td>AIRPORT-30</td><td>Use of airport wireless communication infrastructure for mobile data'</td></tr>
<tr><td>CTE-C02b</td><td>A/G Datalink over ATN/OSI - Single frequency</td></tr>
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<tr><td>CTE-C02f</td><td>Future Satcom for ATM- P15.2.5 Precursor for SBB</td></tr>
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</td>
<td>V2</td><td></td><td></td><td>V3</td><td></td>
</tr>
</table>

Identification of CNS related needs

- Navigation needs:
    - SBAS/GBAS/ABAS GNSS receivers on-board and GBAS equipment on ground
    - Data integrity preservation must be included in GALILEO SoL / PRS service classes
    - Virtual stop bars, and AGL Control
    - E-charts data, Airport Moving map
- Communication needs:
    - Communication interface between TWR and AGL system
    - Secure air-ground data-link
    - Data-link services (e.g. for aircraft, the D-TAXI application standardised by RTCA SC214 / EUROCAE WG-78 for start-up, push-back and taxi clearances as well as special airport operations such as taxiing to/from a de-icing area.)
    - Data-link services for uplink of aeronautical or MET data for use by relevant on board system
    - On board management of additional up linked data e.g. dynamic update of runway/taxiway status during flight
    - Communication interface to send route information to partner systems
    - Uplink of virtual stop bar statuses and position information
- Surveillance needs:
    - ADS-B surveillance/MLAT/SMR/Remote Surveillance
    - A-SMGCS Surveillance
    - Data integrity preservation must be included in GALILEO SoL / PRS service classes

Identification of MET/AIM related needs

- MET/AIM needs:
    - Availability/access to up-to-date terrain/obstacles/aerodrome database
    - MET services
    - Enhanced MET Data sharing among stakeholder for a common awareness and improved surface planning under LVP

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- AIS/MET data can be transmitted to the aircraft using SWIM.

SESAR Solution PJ.03a-03: Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface

Solution Description:

The key information for integrated surface management is accurate and available navigation information with high integrity provided by aircraft. Currently, the navigation information (position of aircraft) is provided by ADS-B, where GPS is primarily used as navigation information source. GPS or

Galileo as standalone systems do not provide sufficiently accurate navigation information for coordinated and safe movement of aircraft during taxi. Multi-constellation / multi-frequency GNSS provides better performance and more robust capability for surface movement.

However, in case of GNSS outages, interference, scintillation and/or multipath - especially while taxiing close to gates on airport surface, alternative sources of navigation are also required. The inertial navigation system is the baseline system for this solution but due to unconstrained drift, it has to be aided by other sources of navigation information such as odometers, vision based systems and/or LIDAR sensor, millimetre wave radar and signals of opportunity.

GNSS augmented system can be used to improve the navigation accuracy of aircraft navigation (position, velocity and time) in both take-off/landing operations and surface movement navigation. The improved accuracy of aircraft position, shown on the on-board navigation display, allows minimising the impact of bad weather on surface operations. Airport service vehicle position accuracy can also be improved by using GBAS or SBAS corrections.

Poor weather conditions have a negative impact on traffic predictability (and overall airport capacity) and may influence safety of taxi phases. Use of GNSS (including GBAS or SBAS) and alternative sources of navigation (in GNSS-denied environment) during taxiing could significantly reduce those negative impacts. Benefits are expected mostly in predictability (maintained during low visibility conditions) and safety (due to increased accuracy in aircraft position during non-nominal conditions or unexpected phenomena like jamming, interference, scintillation and multipath).

The efficient transition between the runway and the taxiway in Low Visibility Conditions (LVC) might be highly beneficial for runway throughput and thus for surface management as a whole. It might be realized with a standalone airborne function to vacate more efficiently the runway and with a linkage to ATC through a downlink message when the runway is vacated. The specific scope of this concept will be assessed through fast-time and real-time simulations to identify the benefits and the operational requirements.

It is important that the position that flight crew has and the position that the ATCO has are consistent. The issue shall be investigated in the project.

The solution to be developed here will be built upon the outcomes of the projects executed within SESAR 1.

Solution PJ.03a-03 shall address the:

- Definition of requirements for navigation on the airport surface;
- Assessment of feasibility, trade-off between benefits and complexity of possible combinations of enabling technologies;
- Fast-time simulation and real-time simulation loops with airborne prototypes and simulators; and
- Solution prototypes development and verification/validation execution.

Solution PJ.03a-03 shall provide:

- Technical definition (requirement consolidation); and
- Prototype development and verification/validation.

The project will also produce deliverables whose content could be suitable for updating and developing existing standards.

The identified solution will be developed at prototype level. As the solution will comprise airborne and ground equipment, verification of single components, their integration and the solution validation at system level will be performed on a common platform and be ready for deployment in large-scale demonstrations.

Operating Environment: small, medium and large airports.

This solution addresses the Airspace Users' needs by:

- increasing capacity in low visibility conditions and enhancing accessibility at small, medium and large airports,
- maintaining or increasing current level of safety with increasing traffic,
- integrating planning to increase punctuality and predictability,
- better recovery in disruption scenarios (CDM, DCB),
- containment of pilot workload in critical situations.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.03a-03
Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AUO-0613 "Enhanced navigation and accuracy in LVC on the airport surface"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-02a</td><td>Enhanced positioning using GBAS single frequency</td></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>CTE-N07b</td><td>GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)</td></tr>
<tr><td>CTE-N13a</td><td>A-PNT (Alternative Positioning Navigation and Timing)</td></tr>
</table></td><td>Not addressed</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
</table>

Identification of CNS related needs

Navigation needs:

- Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5) including GBAS/SBAS and associated avionics systems
- Security functions like authentication and integrity protection for Safety of Life class of

service, or the adoption of PRS, has to be taken into consideration

- Inertial Reference Systems

Communication needs:

- Secure air-ground Data-link

Surveillance needs:

- ADS-B surveillance

Identification of MET/AIM related needs

AIM needs:

- Availability/access to up-to-date terrain/obstacles/aerodrome mapping database

MET needs:

- Enhanced MET Data sharing among stakeholder for a common awareness and improved surface planning especially in LVC

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

It is possible to pass the information via SWIM G/G infrastructure and Airport Datalink (e.g. AeroMACS) to pilot or via SWIM A/G infrastructure or Airport Datalink (e.g. AeroMACS) to pilot in a "secure" way in order to ensure the integrity and the availability of the data for safety reasons as well.

SESAR Solution PJ.03a-04: Enhanced Visual Operations

Solution Description:

This SESAR Solution provides the flight crew:

- with a synthetic/graphical view of the environment using sensor and synthetic terrain imagery, aerodrome surface information (e.g. routing networks) and position/attitude information;
- with the ability to land, taxi and take-off in low visibility/ceiling conditions. Aircraft capability is improved with new on-board features that provide advanced vision (e.g. Combined Vision System, mixing Enhanced Vision System and Synthetic Vision System) in order to take benefit from the ability of the crew to control the aircraft with visual references. Advanced vision systems goal is to compensate the lack of natural vision due to reduced visibility. It will allow the aircraft to be less dependent on ground based infrastructure at the airport while conducting these operations.

Work on Enhanced Vision System (EVS) and Synthetic Vision System (SVS) concepts will also be performed to enable more efficient taxi, take off, landing operations in low visibility conditions. This is applicable to all aircraft categories and, even if mainline aircraft have auto land capabilities to facilitate approaches in low visibility conditions, they have no capabilities to facilitate taxi operations. Visibility can be such that auto-land is possible, but a higher minimum visibility is still required to taxi off the runway to gate, or for taxi out when only using AGL for guidance. Improved access into small airports in low visibility conditions shall be targeted, too.

The graphic concepts that will be used integrate visualizations based on correlation of enhanced vision sensor and database information. Mainline platforms will be used as the basis for the Business and General Aviation validation but other prototyping tools might be required for other platforms. Whilst the operational flight safety benefits are an important aspect of Enhanced Vision Systems (EVS), it is mainly the operational efficiency aspects that will be scrutinized in this solution, e.g., landing, taxi and take-off in low RVR conditions. The EVS sensor selection activity should be common to both the HDD and HUD solutions. The candidates for enhancement of HDD and HUD data will cover: infrared, active 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 low visibility conditions.

Furthermore, new enhanced vision aircraft based sensor equipment offers new capabilities for other systems and purposes, e.g. data from EVS LIDAR or Millimetre Wave (MMW) radar sensor could bring additional in-situ information on weather (like Aircraft Meteorological Data Relay – AMDAR). More specifically, the same kinds of sensors (radar and LIDAR) are already in use and valuable sensors in ground based weather monitoring systems. Infrared cameras are also scrutinized to be useful for the detection of environmental conditions. Therefore, the possibility to make use of aircraft based EVS sensors for improved and more reliable weather/visibility products during approach, decent and taxiing in combination with ground based weather sensors/systems will be investigated. This work will focus on sensor performance specification in terms of feasible MET Information retrieving with respect to different trajectories and synergies with MET sensors.

The targeted solution will ease the development of local/regional airports aiming at enhancing accessibility (SBAS/GBAS navigation supported by enhanced vision systems in lieu of natural vision up to proper visual transition points) and safety with an emphasis on low ground infrastructure needs.

The activities in this solution present continuation and further extension of SESAR 09.29 worked on within SESAR 1. There is also a link with LSD.02.02 project, which will be demonstrating similar technologies only for landing (e.g. SVGS enabling lowering of decision height by 50ft to 150ft). The differences in this proposed solution and LSD.02.02 include lower decision height achieved in this proposed solution bringing further benefits, as well as areas of focus – taxi and take-off operations are targeted.

Due to these advanced on-board avionics:

- The airport access is maintained in low visibility/ceiling conditions;
- The aircraft (included RPAS, GA, BA and rotorcraft) will be less dependent on ground based infrastructure at the airport while conducting taxi, landing and take-off operations;
- In addition, the flight crew will be able to maintain an awareness of taxiway and runway centrelines.

Solution PJ.03a-04 shall address the:

- Definition of requirements for sensors, procedures, data bases, data link, display hardware, symbology overlay, lighting, navigation solutions and human factors concepts.
- Assessment of feasibility, trade-off between benefits and complexity of possible sensors and navigation solutions to be used.
- Solution prototypes development and verification/validation execution.

Solution PJ.03a-04 shall provide:

- Technical definition (requirement consolidation).
- Prototype development and verification/validation.

The project will also produce deliverables whose content could be suitable for updating and developing existing standards.

The identified solution will be developed at prototype level. As the solution will comprise airborne equipment, verification of single components, their integration and the solution validation at system level will be performed on a common platform and be ready for deployment in large-scale demonstrations.

Operating Environment: small, medium and large airports.

This solution addresses the Airspace User's needs by:

- Increased capacity in low visibility conditions including enhanced accessibility at small airports in LVC;
- maintaining or increasing current level of safety with increasing traffic;
- integrated planning to increase punctuality and predictability;
- better recovery in disruption scenarios (CDM, DCB);
- containment of pilot workload in critical situations;
- Improved weather monitoring by using new technologies.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.03a-04
Enhanced Visual Operations</th><th colspan="5">MATURITY</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>AUO-0404 “Synthetic Vision for the Pilot in Low Visibility Conditions”
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-23a</td><td>Synthetic vision in low visibility conditions</td></tr><tr><td>AIMS-16</td><td>Electronic Terrain and Obstacle Data (TOD)</td></tr></table></td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
<tr><td>AUO-0405 “Equivalent Visual Landing operations in Low Visibility Conditions”
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-23b1</td><td>Combined Vision for Equivalent Visual Landing operations in LVC</td></tr></table></td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
</table>

<table>
<tr>
<td>AUO-0406 “Equivalent Visual Taxi operations in Low Visibility Conditions”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-02b</td><td>Enhanced positioning using multi constellation GNSS dual frequency</td></tr>
<tr><td>A/C-23b2</td><td>Combined Vision for Equivalent Visual Taxi operations in LVC</td></tr>
<tr><td>CTE-N07c</td><td>GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)</td></tr>
</table>
</td>
<td>Not addressed</td>
<td>V1</td>
<td></td>
<td>V2</td>
<td>V3</td>
</tr>
<tr>
<td>AUO-0407 “Equivalent Visual Take-Off operations in Low Visibility Conditions
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-23b3</td><td>Combined Vision for Equivalent Visual Take-off operations in LVC</td></tr>
</table>
</td>
<td>Not addressed</td>
<td>V1</td>
<td></td>
<td>V2</td>
<td>V3</td>
</tr>
</table>

Identification of CNS related needs

- Navigation needs:
  - SBAS/GBAS GNSS receivers on-board and GBAS equipment on the ground
  - Attitude and Heading Reference Systems (required for both head down synthetic vision systems and augmented reality head-up displays)
- Communication needs:
  - secure air-ground Data-link
- Surveillance needs:
  - ADS-B surveillance
  - Enhanced vision sensors (e.g. Short Wave Infrared (SWIR) cameras, millimetre wave radar-based and/or LIDAR sensors) to present pilots with operational picture independent of weather conditions
  - Sensor-simulation tools to be used for real-time simulation of concepts within the whole data chain from sensors to display
  - Sensor fusion (e.g. EO/IR Camera, LIDAR) for enhanced vision system (to improve pilots situational awareness especially for RPAS vehicles).

Identification of MET/AIM related needs

- AIM needs:
  - Availability/access to up-to-date terrain/obstacles/aerodrome mapping database

- MET needs:
    - Availability/access to MET Sensor Systems

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Airport Mapping Information Service

SESAR Solution PJ.03a-09: Surface operations by RPAS

Solution Description:

Remotely Piloted Aircraft Systems (RPAS) that are to operate at airports will have to integrate into an environment which is dominated by manned aviation. To the maximum extent possible, RPAS will have to comply with the existing rules and regulations.

Research needs to be conducted to investigate ways in which RPAS may be able to use a technical capability or procedural means to comply with ATC instructions. This research may lead to changes required or clarifications needed for existing “Rules of the Air”. In addition, research will also need to be conducted on surface operations.

Consequently, specific research needs to determine the impact of integration of RPAS on ATM in the some areas presuming RPAS may not be able to comply with all existing manned operations rules, especially in case of control & command data-link loss between RPAS and the remote pilot, or other emergency cases.

Furthermore, the performance characteristics of RPAS flying in controlled airspace could be different from manned aircraft flying today.

These performance differences can also influence surface operation (e.g. taxiing) and landing and departing phase.

PJ.03a should work in cooperation with PJ.13 in order to investigate RPAS airport integration aspects such as separation criteria, the impact of communications and datalink latency, airport or airfield surface operational concepts, RPAS categorization/classification (including flight planning) and other ATM requirements.

Operating Environment: airports with concurrent manned operations

This solution addresses the Airspace Users’ needs by:

- Identifying the particular requirements of remotely piloted surface operations taking into account that in accordance with the European-RPAS-Roadmap the requirements related to airport and surface operations are:
    - Detect & Avoid (D&A);
    - Automated landing and take-off;
    - Platform operations;
    - Ground movements;
    - Contingency;
- Identifying technologies, in close coordination with PJ.03b, that could support unmanned surface operations and working with PJ.13 to develop technical solutions.
- Investigating interoperability, in close coordination with PJ.03b, between ATC surface safety nets (e.g. runway incursion tools) and RPAS safety nets (e.g. D&A).
- Investigating procedural issues to support unmanned surface operations, including

RPAS pilot, RPAS operator and ATC.

List of OI steps and enablers:

SOLUTION PJ.03a-09 Surface operations by RPAS	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AUO-0617 "Enabling Integrated RPAS Surface Operations	Not addressed		V1		V2

Performance Goals

Hereafter the qualitative description of the main performance goals related to PJ.03a:

- Increasing predictability of operations through better trajectory management and of take-off and landing times within the planning horizon of AMAN and DMAN;
- Improving flight efficiency in particular under low visibility procedures;
- Increasing efficiency of aircraft operations through a better balancing between arrival and departure delay;
- Reduction of fuel emissions per flight by reducing overall arrival, surface and departure delay;
- Reduction of pilot workload in case of low visibilities conditions;
- Improvement in both pilots' and controllers' situational awareness.
- Increasing of the aircraft safety on the airport surface, the better situational awareness provided by vision systems in low visibility conditions will reduce the probability of occurrence of hazardous situations;
- Increasing of runway and airport throughput;

The criteria adopted for evaluation of performance impact (percentage/qualitative analysis) takes into account the descriptions of KPAs and related KPIs (Guidance on KPIs and Data Collection Version 1 (2014), D85, Edition 00.01.01), and the Step2 OFA target validation from B4.1 documentations ([2] B41 Updated Validation Targets S1 S2 - 20130621 V2_1b - FINAL 21JUNE), and the Additional Guidelines and Definitions for DOW Production. These considerations have been integrated with the SESAR Solution PJ.03a concept point-of-view.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Resilience	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.03a-01	M 5-10% avg impact on Airport Capacity thanks to the complete enhanced guidance assistance to Flight Crews on the airport surface			H 10-15% Maintain airport throughput during adverse conditions		H	M						
SOLUTION PJ.03a -03	H 15-20% Improved co-ordinated pre-departure management and arrival metering; reduced workload in the integration of arriving/departing traffic, regarding both Airspace Capacity and Airport Capacity	H 2-5% expected benefits from the optimisation of the times, routes and sequences during taxi out	H	M 20-25% Increase efficiency of aircraft operations through better balancing between arrival and departure delay		H		M Impact with a specific reference concerning the GALILEO class of Service used (Safety of Life SoL – with integrity support, or PRS)					
SOLUTION PJ.03a -04	M	M Improvement on Efficiency in Taxi in LVC and better airport access				H 15-20% impact on Safety thanks to the ability of Flight Crew to maintain an awareness of runway centreline	H 15-20% impact on HP thanks to the ability for Flight Crew to take-off in low visibility conditions						
SOLUTION PJ.03a -09						H				H	M	H	

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.03a-01 **Enhanced Guidance Assistance to Aircraft and vehicles on the Airport Surface Combined with Routing**	N	This solution requires an A/G coordination for data exchange between the crew and the controller. Additional G/G communication might be required as well for additional uplink of information
SOLUTION PJ.03a-03 **Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface**	L	This solution is local allowing an efficient taxiing in LVP conditions
SOLUTION PJ.03a-04 **Enhanced Visual Operations**	L	This solution is local allowing an efficient taxiing in LVP conditions
SOLUTION PJ.03a-09 **Surface operations by RPAS**	N	This solution requires data link to enable route and clearance exchange between ATC and the RPAS

Expected inputs to be considered by the project

The following documents are applicable to all solutions:

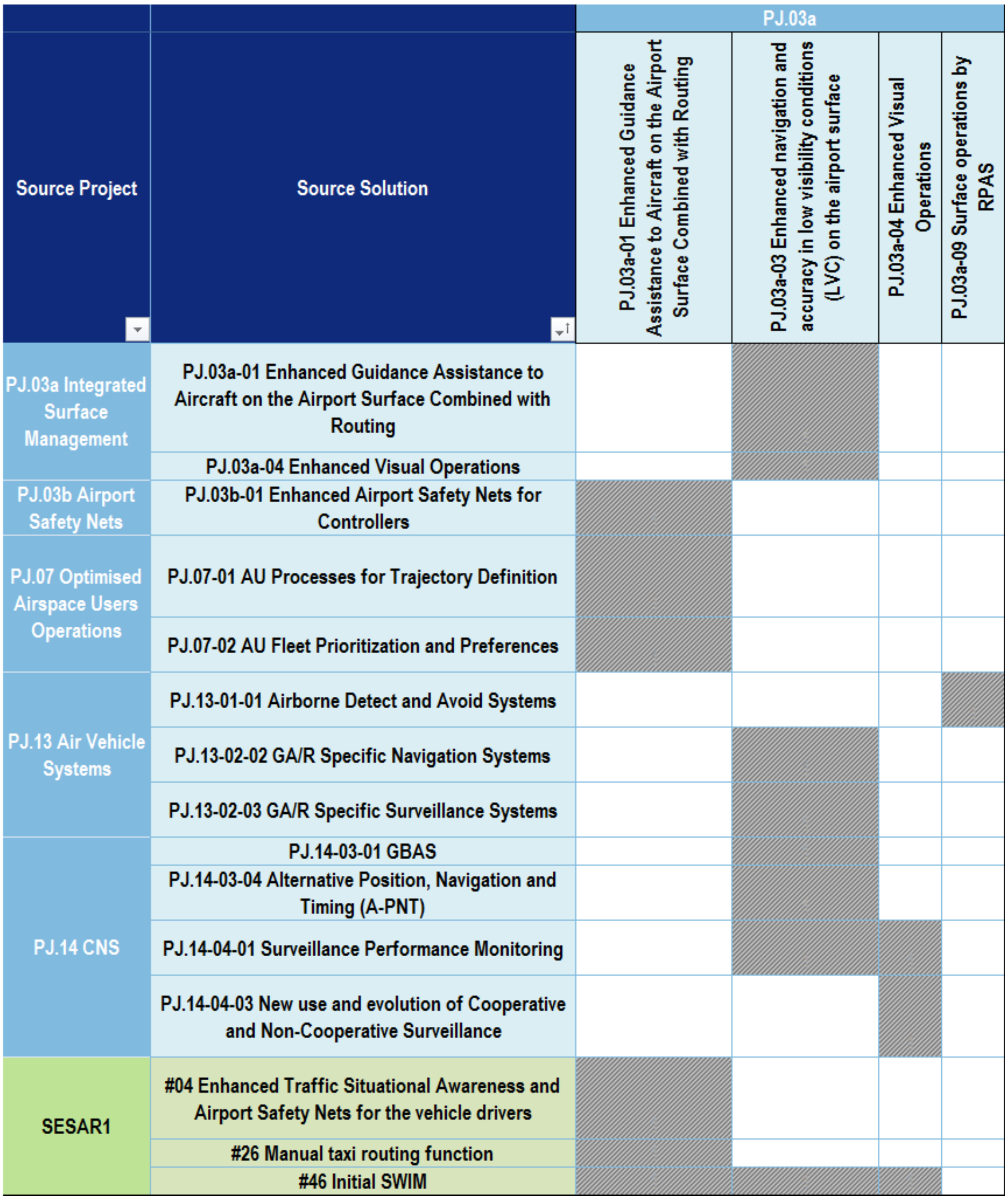
- OFA 04.02.01 final set of deliverables
- OFA 04.01.01 final set of deliverables
- OFA 04.01.02 final set of deliverables
- OFA 05.01.01 final set of deliverables

Dependencies

Dependencies with Other SESAR Solution Projects

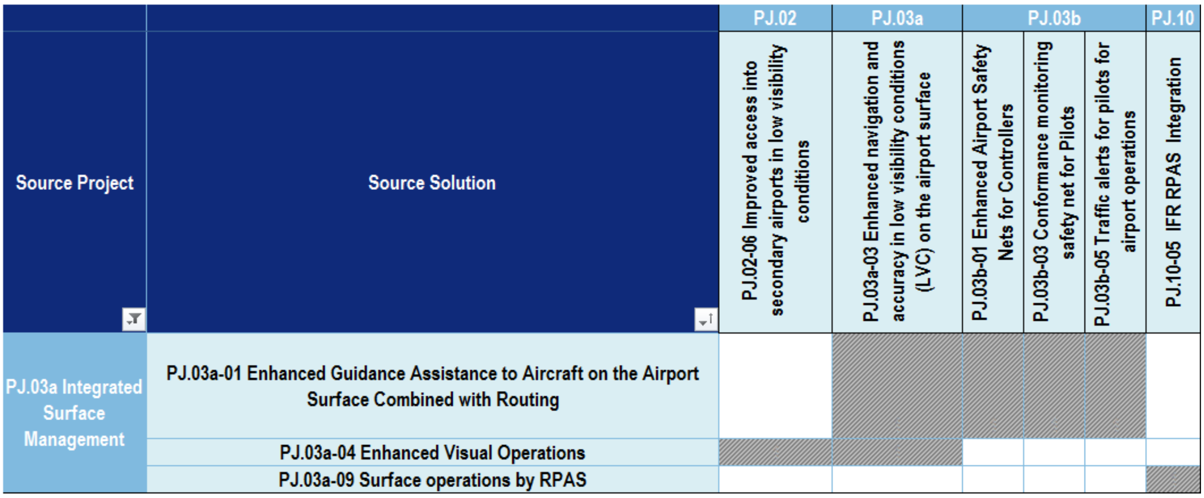
Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.



Source Project	Source Solution	PJ.03a			
		PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing	PJ.03a-03 Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface	PJ.03a-04 Enhanced Visual Operations	PJ.03a-09 Surface operations by RPAS
PJ.03a Integrated Surface Management	PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing		▨		
	PJ.03a-04 Enhanced Visual Operations		▨		
PJ.03b Airport Safety Nets	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	▨			
PJ.07 Optimised Airspace Users Operations	PJ.07-01 AU Processes for Trajectory Definition	▨			
	PJ.07-02 AU Fleet Prioritization and Preferences	▨			
PJ.13 Air Vehicle Systems	PJ.13-01-01 Airborne Detect and Avoid Systems				▨
	PJ.13-02-02 GA/R Specific Navigation Systems		▨		
	PJ.13-02-03 GA/R Specific Surveillance Systems		▨		
PJ.14 CNS	PJ.14-03-01 GBAS		▨		
	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)		▨		
	PJ.14-04-01 Surveillance Performance Monitoring		▨	▨	
	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance			▨	
SESAR1	#04 Enhanced Traffic Situational Awareness and Airport Safety Nets for the vehicle drivers	▨			
	#26 Manual taxi routing function	▨			
	#46 Initial SWIM	▨	▨	▨	

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.



		PJ.02	PJ.03a	PJ.03b			PJ.10
Source Project	Source Solution	PJ.02-06 Improved access into secondary airports in low visibility conditions	PJ.03a-03 Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.03b-03 Conformance monitoring safety net for Pilots	PJ.03b-05 Traffic alerts for pilots for airport operations	PJ.10-05 IFR RPAS Integration
PJ.03a Integrated Surface Management	PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing		▨	▨	▨	▨	
	PJ.03a-04 Enhanced Visual Operations	▨	▨				
	PJ.03a-09 Surface operations by RPAS						▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

- Clean Sky
- ICAO
- …

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently applicable standards and regulations are applicable to the work in this project:

- DO-350, Safety and Performance Standard for Baseline 2 ATS Data Communications, Initial Release ((Baseline 2 SPR Standard) Volume I and II
- RTCA DO-351 Volume 1 & 2 Interoperability Requirements Standard for Baseline 2 ATS Data

Communications (Baseline 2 Interop Standard)

- A-SMGCS Level 2, Existent LVC procedures
- SC214/WG78 for datalink

PJ.03a should take in consideration the activities and results coming from:

- ICAO A-SMGCS Level 3 and 4 definitions development
- EUROCONTROL work on a Manual for A-SMGCS (OSED + INTEROP).

On-going standardization and regulatory activities where the project should contribute to:

- EUROCAE WG-79 / Enhanced & Synthetic Vision Systems (dormant) and RTCA Special Committee 213 (SC-213)
- EUROCAE Working Group WG-41 / A-SMGCS MASPS and MOPS for A-SMGCS Routing function
- RTCA DO-315B/ EUROCAE ED-179B - MASPS for Enhanced Vision Systems, Synthetic Vision Systems, Combined Vision Systems and Enhanced Flight, June 2011
- RTCA DO-341 Minimum Aviation System Performance Standards (MASPS) for an Enhanced Flight Vision System to Enable All-Weather Approach, Landing and Roll-Out to a Safe Taxi Speed, September 2012
- EUROCAE Working Group WG-44 / Aeronautical Databases
- RTCA DO-272A/EUROCAE ED-99A: User Requirements for Aerodrome Mapping Information
- RTCA DO-291/EUROCAE ED-119: Interchange Standards for Terrain, Obstacle, and Aerodrome Mapping Data

If existing standard are not sufficient to provide runway and taxiway status:

- DO-350, Safety and Performance Standard for Baseline 2 ATS Data Communications, Initial Release ((Baseline 2 SPR Standard) Volume I and II
- RTCA DO-351 Volume 1 & 2 Interoperability Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 Interop Standard)

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (Airport, TMA, En Route, Network),
    - ATM Operational Experience (Airport, TMA, En Route, Network),
    - Airport CDM, Global CDM procedures, Runway management,
    - Cockpit Procedures,
    - ATC users requirements (ground & air),
    - Airspace users, airport and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - RPAS operations
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - Mathematical modelling and operations research,
    - Mathematical optimization
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - AMAN, DMAN, A-SMGCS, DCB,
    - FMS,
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Cyber Security,
    - Verification methodologies,
    - Modelling and simulation of aircraft dynamics (on ground),
    - Guidance and control system design,
    - Modelling and simulation of Air Traffic Management system (notably, on TMA and on-ground),
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Human Performance, Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP

- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.3 High Performing Airport Operations – Airport Safety Nets (PJ03b)

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 V3 mature solutions are planned to be delivered:

- Airport Safety Nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances (Solution #02):
    - Alerts for conflicting ATC clearances are generated based both on ATC clearances input by the controller in the electronic flight strips and on surveillance data (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) (Solution #01) 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). Note: RIL were not addressed in SESAR1;
- Enhanced Traffic Situational Awareness and Airport Safety Nets for the vehicle drivers (Solution #04) in case of risk of collision with aircraft (on taxiways and runways) or restricted/closed area infringement.

Remaining improvements to be addressed:

- Enhanced safety nets for controllers
    - Based on SESAR1 achievements;
    - With a wider scope (e.g. area of interest);
    - Including more live traffic/recorded traffic validations;
    - Including weather aspects;
    - Including airports with limited or no surface surveillance capabilities.
- Completion of work initiated in SESAR 1 on:
    - Traffic alerts provided by the on-board system to the flight crews in case of a risk of collision with an aircraft or a ground vehicle on runway and taxiways;
    - Conformance monitoring alerts provided by the on-board system for the flight crew related to ATC clearances and procedures.
- Furthermore, runway excursions have not been addressed at all in SESAR 1. However, they represent the most frequent accident category for worldwide accidents for the 2004-2009 period (IATA 2004-2009 RE Analysis report). There is a need to fill in this gap and address this safety issue (both take-off and landing situations) with all involved stake-holders.

Besides, as the work on "Airport safety nets for controllers in Step1" will be conducted until the very end of SESAR1 programme (several validation exercises in 2016, final OSED end of September 2016, no final SPR), there is a need for project PjJ.03b to support at least standardisation activities identified as reference and supporting material for the Commission Implementing Regulation (EU) No 716/2014 Article 4(B).

Moreover SESAR 1 has provided the SESAR Solution #04 dealing with the provision of Moving Map and Alert for Vehicle Drivers. There is no standard identified yet in the regulation roadmap whereas the vehicle system should meet A-SMGCS performance expectations. PJ.03b will propose support to regulation activities for vehicles.

Finally, there will be a need to support a reference document for airborne safety nets. **These standardisation support activities (including on SESAR1 Solutions) are seen as a transversal task in the project, with its dedicated efforts.**

Safety nets are the most demanding applications in terms of core surveillance performances. In SESAR 1, most of the work on airport surveillance involved Integrating ADS-B source, and most of the requirements that have been identified have been postponed to SESAR 2020. There will be a need to further work on this functional block (false alerts rate is a key issue), including the study of possible new sources such as visual docking (when aircraft are at the Gate and current surveillance is an issue), or video-based surveillance.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

In SESAR 2020, Project PJ.03b will address the development of new Airport Safety support tools for pilots and controllers during airport operations, together with the completion of the work initiated in SESAR 1 for some safety nets (V1, V2 and/or initial V3). 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 (**Solution PJ.03b-01**);
- Conformance monitoring safety alerts for the flight crew (either generated by the on-board system or uplinked from the controller alerting system): the system detects non-compliance with airport configuration (e.g. closed runway, non-compliant taxiway, restricted area…) as well as non-conformance to procedure or clearances (**Solution PJ.03b-03**);
- Traffic alerts for the flight crew (**Solution PJ.03b-05**): The on-board system detects potential and actual risk of collision with other traffic during runway and taxiway operations and provides the flight crew with the appropriate alert;
- Runway excursions safety support tool (**Solution PJ.03b-06**): The system provides support and alerts to the controllers and/or pilots in case of risk of runway excursion (take-off and landing);

Following coordination with PJ.16, work on the HMI for controller safety nets will be addressed in this project (SESAR Solutions 03b-01 and 03b-06): development of requirements, mock-ups when needed, and prototypes.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.03b-01: Enhanced airport safety nets for controllers

Solution Description:

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.

Appropriate alerts are provided to the controllers:

- Detection of conflicting situations on the entire airport surface (e.g. deadlock situations and aircraft pushing back and blocking aircraft taxiing behind them)
- Detection of conflicting ATC clearances including taxiway and apron, and preventive information provided to the ATCO;
- Address implementation limitations in AO-0104-A, for example due to limitations in airport surface surveillance (work with traffic recordings, live trials/shadow mode will be needed);
- Assessment of safety nets with VFR and rotorcraft traffic, possibly RPAS (based on actual surveillance data): different kinematics/trajectories and issues on surveillance may be impact the safety nets behaviour;
- Interoperability of alerts (e.g. consistency with alerts for pilots and co-existence of different alerts for ATCOs). This has been initiated in SESAR1 and needs to be continued as some activities were cancelled (did not fit anymore in the timeframe of SESAR1 due to the late validation activities) and some new safety nets will be studied in SESAR2020.
- Detection of conflicting clearances without surface surveillance/limited surveillance, to develop

solutions for airports with low/medium traffic density. They usually represent a specific operational environment that is characterised by the high seasonal fluctuations and highly inhomogeneous traffic mix consisting of both general aviation (including VFR traffic) and scheduled or charter commercial traffic. These operational features of the regional and low traffic density airports together with a limited surface surveillance infrastructure installed at these airports create potentially hazardous operational conditions.

The work on enhanced surveillance is considered as being part of this project and requirements will have to be defined within the scope of safety nets for controllers SESAR solutions.

The work on this SESAR solution will have to start with a consolidation of SESAR 1 activities depending on the status at SESAR 1 closure and need of support for PCP/WG-41 as there are very late activities and trials in SESAR 1 within the scope of Release 5.

Some additional topics/needs might derive from these validations. They will have to be integrated into these SESAR Solution activities.

Besides, weather hazard situations will also be addressed, e.g.:

1) How to use / present weather phenomenon warning or alerts efficiently to tower controllers;

2) To propose assistance/decision support tools to the controller, enabling them to determine that the current or forecasted weather situation may not be hazardous for the current or anticipated operational situation (e.g. appropriate runway configuration, aircrafts not de-iced, incompatible selected runway exit vs with runway contamination/a/c type,).

For ATCOs, the information on hazardous meteorological phenomena (e.g. microbursts and downbursts, fronts, etc.) causing wind-shear or cross-wind along the approach and departure corridors, are of paramount importance as they might be the only reference of such information for aircraft that are not fitted with an on board meteorological equipment capable to detect these phenomena (e.g. GA).

Note: as far as validation activities are concerned, SESAR 1 showed a gap, with mostly RTS trials. Validations using recorded traffic and live trials will be needed. RTS will be needed as well in order to provoke (and test) safety critical situations (they can be fed by recorded plus synthetic traffic). This will support study into the acceptable level of false and nuisance alerts, particularly those that may lead to unnecessary go-arounds or aborted take-offs.

Operating Environment: all airports, especially those with complex layouts and/or with high traffic density.

<u>List of OI steps and enablers:</u>

<table>
<tr><td rowspan="3">SOLUTION PJ.03b-01
Enhanced Airport Safety Nets for Controllers</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td></td><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AO-0104-B “Airport Safety Nets for Controllers in Step 2”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-23b</td><td>Control workstation fed with enhanced surveillance to support new safety alerts in Step 2</td></tr>
<tr><td>AERODROME-ATC-24</td><td>Surface movement control workstation equipped with advanced tools for predictive indications and alerts.</td></tr>
</table></td><td>Not addressed</td><td></td><td>V2[6]</td><td></td><td>V3</td></tr>
</table>

<u>Identification of CNS related needs</u>

- Enhanced core surveillance should be identified as an enabler of this solution because the number of false alerts must be reduced as we increase the number of alerts + expansion of A-SMGCS Area of Interest (AOI) to fit the needs of new safety tools to detect in advance potential risks; However, the core surveillance is a functional block in itself and is not limited to CNS aspects (sensors). Development of surveillance requirements for safety nets needs is assumed to be part of PJPJ.03b.

<u>Identification of MET and AIM related needs</u>

- MET needs:
    - The project will assess in particular the need for Nowcast and Observation services as surface safety net inputs.
- AIM needs:
    - Consideration needs to be given to the availability of the required ‘infrastructure’-information conveyed in the form of aerodrome mapping information, Terrain and Obstacle Databases (TODs) Area 3 (aerodromes/heliport area) information and D-NOTAM.

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Not applicable to this solution

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[6] On some subjects, what remains to be done is validation through live trials at airports. Some additional topics may start at V2.

SESAR Solution PJ.03b-06: Safety support tools for runway excursions

Solution Description:

Background

A runway excursion is the event in which an aircraft veers off or overruns the runway surface during either take-off or landing. Runway excursion is recognized as a major contributor to accidents worldwide and as an important risk to aviation safety. Many initiatives (operational, training ...) are already in place to cover this critical issue. New airborne capabilities are emerging and provide some airborne functions allowing a reduction in runway excursions for departure and landing. EASA is assessing the opportunity to mandate a Runway Overrun Awareness and Avoidance System (ROAAS). Some initial standardization studies have already started within EUROCAE.

Goal

As a result the objective is to propose a SESAR 2020 solution for runway excursion in consistent liaison with the current initiatives and offering significant benefits for ATM in terms of safety and efficiency. This SESAR solution will take "on board" existing airborne and ground capabilities as the baseline but will go further in proposing a set of operational gains in terms of safety and efficiency thanks to new incremental capabilities.

Working method

Wave 1 timeframe

The activity will consist of analysing the causal and contributing factors (based on already existing material such as the EUROCONTROL Action Plan for the prevention of Runway Excursions, Released Edition 1.0 - January 2013) and identify potential solutions (ATC, on-board, other). All stake-holders (e.g. ANSPs, aircraft manufacturers, airports ...) need to be involved and work together on this safety issue to see what set of solutions can be developed (and by whom).

The end result will consist of defining the SESAR solution in three time steps:

- The reference and short term solution which will be based on "quasi" existing functions to be quickly eligible for deployment.
- The mid-term solution of promising functions (Target V3 by end of SESAR 2020 Wave 2).
- The long term solution which can be seen as an entry point for future exploratory research.

Wave 2 timeframe

Prototyping of the most promising functions, depending on user segments, according to the operational case performed in wave 1. The purpose is to validate identified functions at V3 maturity level covering landing, take-off and approach.

Other points

- As runway excursion is not yet part of the ATM master plan, it is proposed to add OI steps and A/C enabler in the integrated roadmap if the solution is retained.

- Enhanced Runway Condition Awareness (currently identified also as PJ.02-09; main benefit being Safety) will be one input to this SESAR Solution (together with potentially other aspects, such as detection of un-stabilised approach for instance).

Operating Environment: all airports

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.03b-06
Safety support tools for runway excursions</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AO-0107 "Safety Support tools for Tower Controllers for Better Prevention of Runway Excursions”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-31</td><td>Surface movement control workstation equipped with tools to better prevent runway excursions</td></tr>
</table>
.</td><td>Not addressed</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
<tr><td>AUO-0616 "Safety support tools for Pilots for Better Prevention of Runway Excursions"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-73</td><td>Energy monitoring during approach to avoid runway excursion</td></tr>
<tr><td>A/C-74</td><td>Enhanced landing system monitoring to avoid runway excursion</td></tr>
<tr><td>A/C-75</td><td>Take-off system monitoring to avoid runway excursion</td></tr>
</table>
.</td><td>Not addressed</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
<tr><td>AO-0216 "Enhanced Runway Condition Awareness"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-26</td><td>Runway condition awareness management system based on runway built-in sensors</td></tr>
<tr><td>AERODROME-ATC-32</td><td>Runway condition awareness management system based on weather-based runway condition model</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
</table></td><td>Not addressed</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
</table>

Identification of CNS related needs

- None

Identification of MET/AIM related needs

- MET information will be needed.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None

SESAR Solution PJ.03b-03: Conformance monitoring safety net for pilots

Solution Description:

The System detects non-compliance with airport configuration (e.g. closed runway, non-compliant taxiway, and restricted area) as well as non-conformance to procedures or clearances. Whatever the case, the flight crew is provided with the appropriate alert, generated by the on-board system. A full on-board airport safety net will improve safety in runway and taxiway operations, mostly at airports where no safety net is provided to controllers.

However, care will be taken to ensure that this SESAR 2020 solution is interoperable with ground safety nets featuring a similar function (as identified also in SESAR Solution PJPJ.03b-01).

For route deviation alerts, a route needs to be available on board (either uplinked or input by the pilot).

Operating Environment: all airports (complex layouts and/or with high traffic density and smaller airports where "Airport Safety Nets for Controllers is not provided).

List of OI steps and enablers:

SOLUTION PJ.03b-03 Conformance monitoring safety net for Pilots	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AUO-0614 "Conformance monitoring alerts for Pilots"	V2			V3	

Enabler Code	Enabler Title
A/C-43b	Onboard alerts on airport surface related to the conformance to clearances
A/C-43c	Onboard alerts on airport surface related to the compliance to the airport configuration

.

<u>Identification of CNS related needs</u>

- A-SMGCS routing & guidance functions for the detection of taxi clearance deviations in case they are included.

Identification of MET and AIM related needs

- AIM needs:
    - AIM should provide safety nets with relevant information including temporal obstacles through D-NOTAM, TOD Area 3 information, Aerodrome mapping information and runway, taxiway and apron status.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

Not applicable to this solution

SESAR Solution PJ.03b-05: Traffic alerts for pilots for airport operations

Solution Description:

The on-board system detects potential and actual risk of collision with other traffic during runway and taxiway operations and provides the flight crew with the appropriate alert.

The work on this solution has started in SESAR1 P09.14 (and is linked to the RTCA DO-323 SURF-IA application) but needs to be completed in SESAR 2020. with:

- a wider validation including Real Time Simulation coupled with a representative ground platform;
- a wider validation including flight test for traffic alert algorithm validation;
- the completion of the standardisation activities in liaison with EUROCAE/RTCA;
- the validation of ADS-B performance for the traffic alert function;
- Consideration of specific requirements for RPAS.

Operating Environment: all airports (complex layouts and/or with high traffic density and smaller airports where “Airport Safety Nets for Controllers” is not provided).

List of OI steps and enablers:

<table>
<tr><td rowspan="3">SOLUTION PJ.03b-05
Traffic alerts for pilots for airport operations</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td>Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1
R6 | R7 | R8</td><td>Wave 2</td></tr>
<tr><td>AUO-0605 “Traffic alerts for Pilots during runway operations”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-24</td><td>Airport moving map and own aircraft position display in cockpit.</td></tr>
<tr><td>A/C-25</td><td>Airborne Traffic Situational Awareness to support surface operations (ATSA-SURF), including reception (ADS-B in), processing and display</td></tr>
<tr><td>A/C 43a-1</td><td>On-board alerts on airport surface related to traffic at proximity of runway</td></tr>
<tr><td>A/C 48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>CTE S03e</td><td>ADS-B transmitter for vehicles</td></tr>
<tr><td>REG 0200</td><td>Safety Targets in Relation to Reductions of Runway Incursions</td></tr>
</table>
</td><td>V2</td><td></td><td>V3</td><td></td><td></td></tr>
<tr><td>AUO-0615 "Traffic Alerts for Pilots during Taxiway Operations"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-24</td><td>Airport moving map and own aircraft position display in cockpit.</td></tr>
<tr><td>A/C-25</td><td>Airborne Traffic Situational Awareness to support surface operations (ATSA-SURF), including reception (ADS-B in), processing and display</td></tr>
<tr><td>A/C-43a2</td><td>Traffic Alerts for Pilots during Taxiway Operations</td></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
</table>
.
</td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
</table>

<u>Identification of CNS related needs</u>

- A/C enablers A/C 24, 25, 43a, 48a provide an exhaustive view of what is needed for the SURF-IA function. With a CNS allocation:
    - A/C 24 is the navigation part for the aircraft Moving Map with own ship position displayed on a CDTI;
    - A/C 25 and A/C43a is the surveillance part for the reception of the ADS-B In traffic and the alert algorithms;
    - A/C 48a is the communication part with the ADS-B out DO 260B as the communication standard for the function

<u>Identification of MET/AIM related needs</u>

- AIM could provide safety nets with relevant data or information like Aerodrome mapping

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Not applicable to this solution

Performance Goals

The main goal for this project is to improve safety levels at the airport for controllers and pilots.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.03b-01 Enhanced Airport Safety Nets for Controllers					**H**	**H**					M	
SOLUTION PJ.03b-03 Conformance monitoring safety net for Pilots					**H**	**H**					M	
SOLUTION PJ.03b-05 **Traffic alerts for pilots for airport operations**					**H**	**H**					M	
SOLUTION PJ.03b-06 **Safety support tools for runway excursions**					**H**	**H**					M	M

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.03b-01 **Enhanced Airport Safety Nets for Controllers**	L / N	
SOLUTION PJ.03b-03 **Conformance monitoring safety net for Pilots**	L/N	A/G aspects for airport maps/NOTAMS? Potentially for uplink of alerts although relevance is still to be evaluated.
SOLUTION PJ.03b-05 **Traffic alerts for pilots for airport operations**	N	A/A exchanges, need for coordination on expected performances for ADS-B out?
SOLUTION PJ.03b-06 **Safety support tools for runway excursions**	L/N	

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.03b-01 Enhanced Airport Safety Nets for Controllers:

- SESAR 1 P06.07.01-D32 Final OSED for Safety tools for Tower Controllers (updated after the R5 exercises)
- SESAR 1 P06.07.01-D29 Updated SPR for OFA ATCO Safety tools following V2 CMAC trials and V3 CATC trials (but not updated after V3)
- SESAR 1 P06.07.01-D05 Operational concept for the integration of the safety support tools: updated OCD (third year)
- SESAR 1 P06.03.01 Release5 VALR D149
- SESAR 1 P12.03.02 D64 Phase3 - Technical Specifications - Final Report (but D64 will not be in line with D32 as the technical specifications will only be updated on requirements status after V3 by P12.03.02)

Solution PJ.03b-03 Conformance monitoring safety net for Pilots in Step 2:

- SESAR 1 P09.14 D39 Updated OSED for "Conformance Monitoring for pilots" following V2 trials
- SESAR 1 P09.14 D40 Consolidated Updated SPR for "Conformance Monitoring for pilots" following V2 trials
- SESAR 1 P09.14-D36 Final OSED for "Traffic Alerts for pilots" following V3 trials
- SESAR 1 P09.14-D37 Consolidated Final SPR for "Traffic Alerts for pilots" following V3 trials
- SESAR 1 P09.14-D38 Consolidated Final INTEROP for "Traffic Alerts for pilots" following V3 trials

Solution PJ.03b-05 Traffic alerts for pilots for airport operations:

- SESAR1 P09.14 D36 Final OSED for "Traffic Alerts for pilots" following V3 trials
- SESAR1 P09.14 D37 Consolidated Final SPR for "Traffic Alerts for pilots" following V3 trials
- SESAR1 P09.14 D38 Consolidated Final INTEROP for "Traffic Alerts for pilots" following V3 trials

Solution PJ.03b-06 Safety support tools for runway excursions:

- EUROCONTROL Action Plan for the prevention of Runway Excursions, Released Edition 1.0 - January 2013)

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.03b			
Source Project	Source Solution	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.03b-03 Conformance monitoring safety net for Pilots	PJ.03b-05 Traffic alerts for pilots for airport operations	PJ.03b-06 Safety support tools for runway excursions
PJ.02 Enhanced Runway Throughput	PJ.02-09 Enhanced Runway Condition Awareness	▨			▨
PJ.03a Integrated Surface Management	PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing	▨	▨	▨	
PJ.13 Air Vehicle Systems	PJ.13-02-01 GA/R Specific Communication Systems				▨
	PJ.13-02-02 GA/R Specific Navigation Systems				▨
	PJ.13-02-03 GA/R Specific Surveillance Systems	▨		▨	
PJ.14 CNS	PJ.14-04-01 Surveillance Performance Monitoring	▨	▨		
	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	▨			
PJ.18 4D Trajectory Management	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	▨			
SESAR1	#02 Airport Safety Nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances	▨			
	#22 Automated Assistance to Controller for Surface Movement Planning and Routing	▨	▨		
	#23 D-TAXI service for CPDLC application	▨	▨		
	#26 Manual taxi routing function	▨			
	#48 Virtual Block Control in LVPs	▨			

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.02	PJ.03a
Source Project	Source Solution	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing
PJ.03b Airport Safety Nets	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	▨	▨
	PJ.03b-03 Conformance monitoring safety net for Pilots	▨	

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;

- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

None at the moment

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently applicable standards and regulations are applicable to the work in this project:

- The Current ICAO A-SMGCS Manual 9830 refers to current implementation levels and would need to be updated.
- IR SPI 1207/2011 should make clearer the need of performances (surveillance) including for surface operations.

On-going & Future applicable standardisation / regulatory activities:

- EUROCAE WG-41 (A-SMGCS documentation): currently planned update of EDs documents as appropriate to cover new SESAR 1 functions like routing and planning and new airport safety nets (AO-0104-A) in support of PCP AF2;
- Further standards for routing & planning, Guidance or Safety nets will require live trials results in order to refine the minimum performance expectation on A-SMGCS surveillance core function;
- A-SMGCS implementation Levels seem obsolete regarding SESAR 1 results. Implementation and deployment criteria for A-SMGCS new Services have to be re-drawn taking into account results from SESAR 1.
- There are no minimum performances for vehicle equipment whereas vehicle reports are used by A-SMGCS MSDF and its new functionalities. Moreover SESAR 1 provides mature solution for alert and situational awareness for vehicle drivers. Because the Safety nets seem the more demanding system in term of Surveillance performances, the project will provide support to the creation of standards for vehicles.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOp,
    - ATM Operational Concept (airport environment…),
    - ATM Operational Experience (airport environment…),
    - ATC users requirements (ground & air),
    - Airspace users, airport operators and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (Airport systems, CNS…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments:
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
    - HF / HMI concept design expertise
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,

- Development of pan-European air traffic management solutions, encompassing Civil/Military dimension,
- Regulatory frameworks, Standardization Bodies, Institutional communication.

Final deliverables for external publication/SESAR Solution Packs

- OSED
- SPR
- INTEROP
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.4 High Performing Airport Operations – Total Airport Management (PJ04)

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. Communication and information exchange between AOP and NOP (Network Operations Plan) takes place continuously, reflecting a common situational view on current and forecasted operations;
- The Airport Operations Centre (APOC) capability, a multi-stakeholder organisational unit, whose main objective is to manage the AOP 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, the airport part of the business trajectory, 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 (A-DCB) concept, particularly current procedures for balancing runway 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 processes.

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

- Achieving the full integration of AOP with NOP;
- Fully integrating landside/airside performance monitoring and management;
- Integrating environmental impacts into the planning and execution timeframes of the AOP;
- Refining the turnaround monitoring within the APOC in coordination with the Airspace Users;
- Improving the impact assessment tools available to the APOC to better integrate information about MET forecast uncertainty;
- Closing the loop regarding de-icing, by integrating all aspects of de-icing into the AOP to allow refinement of airport planning;
- Further developing the collaborative recovery procedures and support tools in coordination with all the relevant ATM stakeholders (Network Manager, Airport Operators, ANSP, Airspace Users);

- Developing Total Airport Demand and Capacity Balancing processes and tools built upon the work achieved in SESAR 1, fully integrated with the execution tools (AMAN/DMAN/A-SMGCS…) and resource allocation planning tools (Stand/Gate Allocation Planner).
- Refining the "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 processes, support tools and reporting capabilities, and using post operations data to develop an airport learning environment (airport business intelligence).

Following SESAR 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.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

In order to close out the gaps identified during the SESAR 1 programme, the project shall address any outstanding aspects related to AOP-NOP interaction still remaining after SESAR 1 activities have been completed.

Therefore elements of work that need to be addressed have been grouped under the two following solutions:

- **Enhanced Collaborative Airport Performance Planning and Monitoring [SESAR Solution PJ.04-01]**
- **Enhanced Collaborative Airport Performance Management [SESAR Solution PJ.04-02]**

This DOW assumes that the on-going work on OI steps AO-0801-A, AO-0802-A, AO-0803, AO-0804 and DCB-0309 (SESAR Solution #21, Release 5) has been completed (achieving v3 maturity) during SESAR 1 timeframe.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

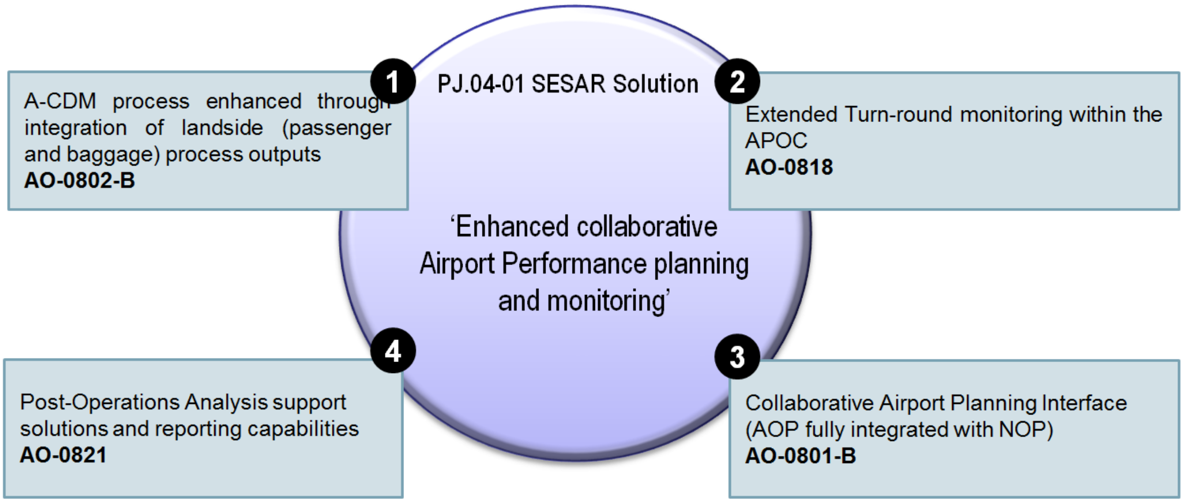
SESAR Solutions

SESAR Solution PJ.04-01: Enhanced Collaborative Airport Performance Planning and Monitoring

Solution Description:

This SESAR solution will build upon:

- [1] Extending the SESAR 1 Airport Performance process monitoring to the airport landside and ground access processes that may have an impact on the airside operations in both planning and execution timeframes; Developing rationalised dashboard(s) fed with all landside and airside leading key performance indicators covering Total Airport Management processes; Consolidating the KPI suite ensuring coverage of both landside and airside operations and focusing on leading performance indicators to support pro-active management of ATM related disruptions.
- [2] Further refining, in association with Airspace Users, a suitable level of turnaround process planning and monitoring within the APOC which would participate in improving operational resilience.
- [3] Improving the connection between the airports with the ATM Network (AOP fully integrated with NOP).
- [4] Providing tools supporting recording, enabling timely analysis of specific events and reporting.



[1] Enhancement of the airside process with the inclusion of landside (passenger and baggage flow) process outputs that can affect ATM performance e.g. through delayed departures.

This concept builds on the SESAR 1 Airport Operations Management Solution. It aims at describing the functional and technical requirements for inclusion of landside processes at an airport in both the planning and execution timeframe. The Airport Operations Management 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 and vice versa. So whilst this project will not perform specific research into the landside/ground access to the airport elements (considered out of the scope of SESAR), it will consider how the knowledge of the current and predicted status and 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 into the ATM Network.

Rationalised dashboards will be developed, fed with appropriate landside and airside key performance indicators covering overall airport processes, such as passenger, baggage, aircraft flows plus environmental and meteorological impacts showing current and forecasted performance.

A KPI suite, covering both landside and airside operations and focusing on leading performance indicators, to support pro-active management of arising situations will be developed. The KPI suite should incorporate and align with the airport relevant Reference Period (RP) metrics (RP2 addresses the period 2015-2019) of the Single European Sky (SES) Performance Scheme. In particular forecasting future performance will permit stakeholders to model what-if scenarios and will support proactive management.

A set of optimization forecasting models will be provided in order to improve passenger and baggage flows impacts on aircraft process. The capacity of foreseeing flow peaks is one of the main points of interest to improve.

[2] Turnaround of an individual airframe is under the control of Airspace Users. However, by monitoring key aspects of the turnaround process, the APOC shall get an early warning indicator of an imbalance of the performance and infrastructure inefficiencies / issues / failures, resulting in possible delays or having any other negative impact on airside operations. Further development needs to be done in association with Airspace Users in regard to defining a suitable level of Turnaround Process Monitoring within the APOC, supporting operational resilience of the pre-departure sequence, and improving departure time predictability. Standard operating procedures and key data identification will address data analysis and processing to improve airspace users' awareness of

operational targets. Together with the User Driven Priority Process (UDPP), this area of development will be a fundamental driver for the definition of advanced communication and pro-active management processes between Airspace Users and the APOC.

[3] Significant work has been done in SESAR 1 around the Airport Operations Plan, especially documentation about which information should be shared with the Network.

However further Airport-Network work and validation (involving PJ.04 and PJ.09) is still needed to:

- Finalise Airport-Network collaborative processes and associated procedures together with enabling AOP-NOP information sharing and contribute to European standardisation.
- Ascertain the benefits that would result on both sides (Airport and Network) if a large number of airports would then proceed to such deployment.
- Fine tune the minimum quality of information expected on both sides (Airport and Network) so that expected benefits can be delivered at European level.
- Contribute to the development of an AOP-NOP information service, in coordination with PJ.09, to be validated in a SWIM environment.

[4] Post Operations Analysis will:

- Support the recording and timely analysis of specific events.
- Provide the ability to quickly find, merge, analyse and replay airport data with linkage to other stakeholder tools (e.g. radar and r/t playback plus aircraft data) to assist the analysis of specific events as well as supporting the identification of gaps and issues.
- Support the automatic generation of periodic airport performance reports (e.g. daily, weekly, monthly, etc.) from data mining, as well as user-defined and fit-for-purpose post operations reports.

GA/rotorcraft/military and RPAS operations in/out of an airport should be included in the demand profile for the airport. This will be captured through the S/RBT provision from the operators or through a separate local arrangement where appropriate. Therefore all airspace users regardless of operating methods will be involved or considered in this solution in order to reach highest possible performance. Therefore they will all benefit from impacted KPAs.

Operating Environment:

- Large and medium size airports.

The applicability/adaptation of this SESAR solution to regional airport will be studied considering the strategic impact of General Aviation/Business Aviation as well as Low Cost airspace users.

List of OI steps and enablers:

SESAR Solution PJ.04-01: Enhanced Collaborative Airport Performance Planning and Monitoring	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AO-0802-B "A-CDM process enhanced through integration of landside (passenger and baggage) process outputs"	V1		V2		V3

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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-35b</td><td>Airport CDM (level 4 - CDM integrated with landside processes)</td></tr>
<tr><td>PRO-249</td><td>Procedures Linked to Collaborative Flight Planning in Step 2</td></tr>
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AO-0818 "Extended Turnaround monitoring within the APOC"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-40</td><td>Airport Performance Monitoring System</td></tr>
<tr><td>PRO-249</td><td>Procedures Linked to Collaborative Flight Planning in Step 2</td></tr>
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<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
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AO-0821 "Post Operations Analysis support solutions and reporting capabilities
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-38</td><td>Airport data recording and analysis system</td></tr>
<tr><td>AIRPORT-09</td><td>Airport data replay system</td></tr>
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<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
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AO-0801-B "Collaborative Airport Planning Interface (AOP fully integrated with NOP)
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-35b</td><td>Airport CDM (level 4 - CDM integrated with landside processes)</td></tr>
<tr><td>AIRPORT-41</td><td>Airport Operations Centre Support Tools</td></tr>
<tr><td>HUM-010</td><td>New role of APOC representative from Ground Handling Agent</td></tr>
<tr><td>PRO-028</td><td>Procedures to support AOP-NOP collaborative process</td></tr>
<tr><td>SWIM-APS-03a</td><td>Provision of ATFCM Information Services for Step 1</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
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<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
</tr>
</table>

In coordination with SESAR1 Project P6.2, it has been agreed:

- To split AO-0802 (A-CDM process enhanced through integration of landside (passenger and baggage) process outputs) in:
  - AO-0802-A (limiting AO-0802-A to passengers only in SESAR 1) and,
  - AO-0802-B (New OI covered by this solution), covering full original AO-0802 scope.

- To split AO-0801 in:
    - AO-0801-A (Collaborative Airport Planning Interface), covered by SESAR1, addressing the maintenance of the evolving content of the AOP including (1) an initial identification of elements that are common between the AOP and the NOP and (2) means to allow the exchange of information between AOP and NOP.
    - AO-0801-B (Collaborative Airport Planning Interface (AOP fully integrated with NOP)), covered by SESAR2020. This OI will address the maintenance of the evolving content of the AOP including (1) the finalisation of AOP-NOP information sharing that would ultimately lead the European standardisation; (2) the procedures to support AOP-NOP collaborative process, including AOP-NOP information quality requirements and (3) the exchange of AOP-NOP information through SWIM.

Identification of CNS related needs

- It is expected that the realisation of the operational objectives of the project will require wireless exchanges of information flows. Therefore it is important to evaluate required application performance from the COM enablers, current and future, including, for example, the newly-developed and standardised at ICAO airport surface data link (AeroMACS).

Identification of MET/AIM related needs

- Specific MET needs include:
    - Combination of relevant MET data (e.g. satellite, radar, and numerical model output) to obtain a consistent "weather picture" of the present and future.
    - Advanced forecasting methodologies being developed in SESAR 1.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- CDM process supported by SWIM services.
- (SWIM) services are required for all data exchange between Surface/Departure/Arrival Management systems and the AOP
- Link to SESAR 2020 SWIM enablers may be required when these are available.
- Use of suitable SWIM infrastructure and services. SWIM enabled validation platform necessary will be required for validation needs.

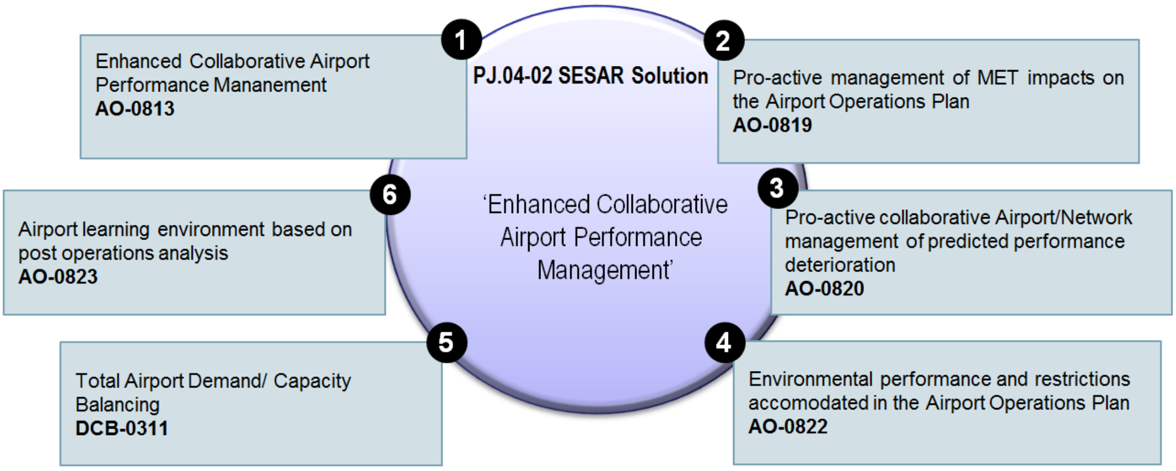
SESAR Solution PJ.04-02: Enhanced Collaborative Airport Performance Management

Solution Description:

This SESAR solution will build upon:

- [1] The development of an APOC 'What-if' decision support suite that accommodates all the key performance flows of the airport, including the creation of a learning post-operations environment and intelligent optimisation for improving what-if computation.

- [2] The pro-active management of meteorological impacts on the AOP.
- [3] The collaborative Airport/Network management of predicted performance deterioration (collaborative procedures and tools).
- [4] The accommodation of environmental performance and restrictions in the AOP.
- [5] Total Airport Demand and Capacity Balancing.
- [6] Post Operations analysis support and reporting capabilities.



[1] 'What-if' decision support suite will be developed, accommodating all the key performance flows of the airport, i.e. passenger, baggage and aircraft flows plus environmental, airport ground access and meteorological impacts, allowing trade-offs between KPAs and efficient support to decision-making between airport stakeholders.

Passenger and baggage presentation curves strongly affects landside management and the supervision model developed in AO-0802-B will help in applying the most appropriate strategies, optimizing transfer times and resource allocation.

[2] This SESAR solution addresses two key issues to support pro-active management, the translation of MET information in impacts and the quantification of their likelihood (predictability). Therefore the focus of the MET contribution will be on the integration of tailored MET information in the ATM and airport management processes, including information on MET forecast uncertainty.

The first level of integration is already deployed at some CDM airports (through national or local MET service providers) and consists in probabilistic MET information on a separate display. SESAR 1 focuses on refining and harmonising the MET information presented to the airport stakeholders. The next step in PJ.04 will be to integrate MET information in impact assessment models to derive an ensemble prediction of the impacts and support DCB with probabilistic impact assessment. The last step in SESAR2020 will be to integrate MET impact assessment in decision support tools to derive optimal solutions in adverse weather conditions.

The MET information covers from observation to 7 days forecast of nominal and significant weather, seamless in space and time, and with progressively finer time steps from 6 hours for the 7 days horizon to 5 minutes for the forthcoming 2 hours. MET uncertainty will be quantitatively assessed using ensemble weather predictions that provide a probabilistic vision of the future.

The translation of MET information into impacts will require a comprehensive model of all kind of significant weather features on each of the airport flows and operations. Probabilistic or ensemble impact assessment can then be derived including user specified probability thresholds on severity and duration.

At the final level of MET integration, poorly predictable weather hazards such as convection, snow and fog are fully accounted for in a cost/loss assessment (the cost of a mitigation measure versus the loss experienced if the hazard is ignored). Each possible realization of the weather is translated in potential impacts and the ensemble provides a statistical measure of the performance risk, hence moving from a reactive to a pro-active/collaborative management of the inherent MET uncertainty, specifically tailored to each ATM process.

Forward planning of a demand/capacity balance strongly relies on the quantifiable impact of weather on airline, airport or aircraft operations that the APOC can use in its planning. This requires the development of a decision support tool that allows the APOC to assess the scenario-based impact of the likelihood of the occurrence of key meteorological conditions and a combination of meteorological conditions on the operations.

Integral part of the development is to develop an understanding and to include in the methodology:

- The identification of the most likely impact of weather scenarios , i.e. a representative set of weather elements and hazards on ATC, airport or aircraft operations at the airport, in particular providing reliable upper and lower boundaries of the impact on the operations;
- The validation of the quantified estimates on the impact of these representative weather scenarios, and in particular the upper and lower boundaries of such impact (e.g. 95 percentile) on the operations;
- The provision of a set of realistic and representative complex weather impact scenarios with interacting elements, and a qualitative description of potential overall impacts as part of the risk management process of the APOC.

The development of such a risk-based assessment methodology for the APOC for issues related to weather needs to be performed in close liaison with the provider of MET information. For SESAR2020, all issues related to developing the appropriate capabilities for MET to meet the information requirements of this solution will be gathered, harmonised, consolidated and managed transversally by PJ.18 (Solution PJ.18-04).

[3] Collaborative Airport/Network recovery procedures and associated predictive and decision support tools will be developed in order to support airport, network, AU (UDPP) and ANSP stakeholders to anticipate, understand and collaboratively manage large scale disruptive adverse events to reduce impact and knock-on effect, optimising solutions whilst ensuring that users' end-to-end processes are managed.

The SESAR 1 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 airport stakeholders. 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.

[4] Environmental sustainability regulations are becoming more and more of a significant restriction for the day to day operation and growth of the current Air Transport System. All ATM stakeholders (Airspace Users, ANSPs and airport operators) need to take into account the (typically local) environmental regulations and considerations in all stages of operational planning and execution.

This SESAR Solution aims at including environmental impact (e.g. noise propagation) 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/or 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.

It also needs to be acknowledged that environmental impact is different among airports as current environmental regulations are set and maintained on a national and not on European level. Embedding environment into airport operations (AOP and APOC) will therefore be locally determined and not a generic solution.

For the Airport Operations Plan and airport performance monitoring, environmental restrictions and performance need to be monitored and accommodated in:

- Airspace design (long term planning phase);
- Airport capacity calculations throughout the planning and execution timeframes;
- Surface Movement planning and routing.

Benefits are expected in ENV KPA.

The technological and operational measures developed in other work packages of the SESAR2020 program should be considered, since they might have a positive impact on the environmental performance of airport operations: e.g. technologies developed in PJ.02 (“Enhanced Runway Throughput”) as well as in PJ.03a. The implementation of such solutions can have contradicting impact on different KPIs of an airport. Integration of such mitigation measures in the TAM framework would create additional benefit.

[5] Total Airport-DCB will be achieved through:

- Pro-active assessment of the available total airport capacity including terminal, stand, manoeuvring area, taxiway and runway capacities, given expected weather and other operational conditions;
- Comparison of the available capacities with the most up to date demand information Reference or Shared Business Trajectories (RBT/SBT);
- Pro-active identification of imbalances and the affected timeframe, trajectories, location of the imbalance;
- Ensuring that balancing meets the UDPP process agreed;
- Integration with tools such as AMAN/DMAN/A-SMGCS using (SWIM) services to ensure that planning on RWY is followed during execution .

A continuous balance between Demand and Capacity within all operational areas of the airport has to be achieved. Building on the Runway DCB Tool (RMAN) developed within SESAR 1 and the specific topic areas development above, a Total Airport Demand and Capacity Balancing tool needs to be developed and integrated. This tool should be able to predict DCB imbalances with immediate or future impacts, identify where the imbalance occurs (e.g. Terminal 2 stands or Northern area taxiway), determine the impact of the DCB imbalance on performance (KPIs – capacity shortage, delay and punctuality) and calculate a new configuration.

The “what if” functionalities of the Airport DCB (A-DCB) will support the adjustment of decision making, supporting UDPP and Network Dynamic-DCB concepts.

Weather will be one of the main enablers of a ‘what-if’ tool. The solution will therefore need to develop a concept of ‘situation-dependent confidence’ for the predicted weather to identify the effects of uncertainty on APOC processes and to prioritize the most relevant processes. This may include the development of user-centric cost / loss ratios for the relevant processes and integrate them in the required tools.

[6] Post Operations support should be capable of:

- Creating a learning environment and intelligent optimisation for adjusting Airport Performance

Framework parameters and improving what-if computation and forecasts, through:

  - More reliable figures for assumptions used in 'what-if' calculation;
  - Better impact calculation (delays, financial impact, …)
  - A correlation engine to support Standard Operating Procedure evaluation through data fusion related to events provided from landside and airside subsystems and stakeholders;
- Maintaining a database with events and solutions applied including a generic and intelligent search function (e.g. keyword research):
  - To automatically retrieve, from past experiences, the most suitable solution(s) for an on-going event (pre-defined solution table).
  - To support the update -if appropriate- of a set of pre-defined solutions.

GA/rotorcraft/military operations in/out of an airport should be included in the demand profile for the airport. This will be captured through the S/RBT provision from the operators or through a separate local arrangement where appropriate. Therefore all airspace users regardless of operating methods will be involved or considered in this solution in order to reach highest possible performance. Therefore they will all benefit from impacted KPAs.

Operating Environment:

- Large and medium size airports.
- The applicability/adaptation of this SESAR solution to regional airport will be studied considering the strategic impact of General Aviation/Business Aviation as well as Low Cost airspace users.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.04-02: Enhanced Collaborative Airport Performance Management</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>AO-0813 " Enhanced Collaborative Airport Performance Management "
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-02</td><td>TTA Airport Impact Assessment Tool</td></tr>
<tr><td>AIRPORT-06</td><td>UDPP Departure on A-CDM Airport system</td></tr>
<tr><td>AIRPORT-07</td><td>Decision support processes/tools for airport operations management</td></tr>
<tr><td>AIRPORT-48</td><td>Advanced Airport UDPP integrated with AOP Monitoring</td></tr>
<tr><td>PRO-249</td><td>Procedures Linked to Collaborative Flight Planning in Step 2</td></tr>
</table></td><td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
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<tr><td>PRO-248</td><td>Collaborative Procedures for improving Airport Operations in Adverse Conditions in Step 2</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
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<td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td>
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<tr><td>AIRPORT-11</td><td>Meteo Advisory Tool</td></tr>
<tr><td>APP ATC 99</td><td>ATC System to use Real-Time Meteo Information Received From Met Systems</td></tr>
<tr><td>PRO-248</td><td>Collaborative Procedures for improving Airport Operations in Adverse Conditions in Step 2</td></tr>
<tr><td>SWIM-APS-07b</td><td>Consumption of Meteorological Information services for Step 2</td></tr>
<tr><td>SWIM-STD-01</td><td>AIRM Package</td></tr>
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-03</td><td>Airports Operation Plan (AOP) management tool</td></tr>
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<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>SWIM-APS-07b</td><td>Consumption of Meteorological Information services for Step 2</td></tr>
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<td>AO-0822 " Environmental performance and restrictions accommodated in the Airport Operations Plan"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-03</td><td>Airports Operation Plan (AOP) management tool</td></tr>
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<tr><td>AIRPORT-12</td><td>Airport Business Intelligence System</td></tr>
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<td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td>
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
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<tr><td>SWIM-APS-05b</td><td>Provision and Consumption of Flight Object Sharing services for Step 2</td></tr>
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</td>
<td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td>
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Identification of CNS related needs

- No specific CNS need identified yet.

Identification of MET/AIM related needs

- (SWIM) services are required for all data exchange between Surface/Departure/Arrival Management systems and the AOP

- As per AOP. If appropriate, workshops will be required in project execution to establish specific project needs.
- Specific MET needs include:
  - Detailed MET information requirements based on the initial analysis of most impacting weather scenarios in terms of cost/loss ratio and the risk management approach adopted.
  - MET information which shall include:
    - A coherent description of all impacting MET phenomena up to some days in advance with a seamless quantification of their severity, with variable time steps ranging from minutes (very short term) to hours (weather forecast for the coming days);
    - Quantified information about MET predictability, i.e. the provision of ensemble MET forecast to be either translated into a probabilistic forecast of weather hazards occurrence or directly integrated into impact assessment tools to develop an ensemble forecast of the impacts.
    - *Note: establishing a close dialogue between MET service providers and system designers developing the impact assessment tools is crucial.*

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Link to SESAR 2020 SWIM enablers may be required when these are available;
- CDM process supported by SWIM services;
- ATFCM information available via SWIM;
- MET information available via SWIM; if appropriate, needed MET service to achieve this solution will be identified and designed.
- Use of suitable SWIM infrastructure and services to be used. SWIM enabled validation platform will be required for validation needs.

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 situational awareness through SWIM information sharing, enabling provision and reception of Airport CDM data including MET and AIM.
- A significant 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.

Solution PJ.04-01

Predictability:

- Conceptual Dimension: High, by extending SESAR 1 processes through integrated process outputs (impact of landside processes outputs are considered onto airside processes), extended turnaround monitoring, leading to improved quality of information about airport operations, ultimately increasing predictability.
- Deployment Dimension: Large application scope since solution could be applied at large and medium airports in Europe – capturing large part of European traffic. In addition, the integration of AOP with NOP part of the solution is expected to contribute to European standardisation of AOP-NOP information sharing, providing more information with increased quality on both Airport and Network side.

Fuel Efficiency:

- Conceptual Dimension: Limited impact achieved through better predictability and planning of operations before departure trajectory execution at the airport (pre-departure sequence). Benefits drawn must be combined with other solution projects (e.g. PJ.02, PJ.03a) in that area.
- Deployment Dimension: Large application scope since solution could be applied at large and medium airports in Europe – capturing large part of European traffic.

Solution PJ.04-02

Predictability:

- Conceptual Dimension: High, through development of what if decision support suite, pro-active management of MET impacts and further developing Airport / Network procedures will support the stakeholders (Airport, Network, Airspace Users, ANSP) to anticipate and collaboratively manage disruptive events and reduce their impact.
- Deployment dimension: Large application scope since the decision support tools toolbox could be applied at large and medium airports in Europe – capturing large part of European traffic.

Capacity:

- Conceptual Dimension: Development of pro-active decision support, ultimately increasing airport capacity.
- Large application scope since the solution could be applied at large and medium airports in Europe – capturing large part of European traffic.

Fuel Efficiency:

- Conceptual Dimension: Limited impact achieved through decision support tools, having a positive impact on predictability of operations and ultimately fuel efficiency. Benefits drawn must be combined with other solution projects (e.g. PJ.02, PJ.03a) in that area.
- Deployment Dimension: Large application scope since solution could be applied at large and medium airports in Europe – capturing large part of European traffic.

	Capacity	Fuel efficiency	Predictability	Safety	Cost effectiveness
SOLUTION PJ.04-01 **Enhanced Collaborative Airport Performance Planning and Monitoring**	No impact	**L** 1%-2% increase of fuel efficiency on the ground through increased predictability of operations before trajectory execution, which contributes to optimisation of pre-departure sequence	**H** Increase by +10%-15% of predictability in planning airport operations, contributing to more predictable business trajectories	No impact	No impact
SOLUTION PJ.04-02 Enhanced Collaborative Airport Performance Management	**H** +10%-15% of capacity expected	**L** 0,5%-1% increase of fuel efficiency on the ground through increased predictability of operations through what-if and decision support tools	**H** Increase by +10%-15% of predictability of airport operations during adverse weather conditions	No impact	No impact

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G(Ground/Ground) or A/G(Air/Ground) integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.04-01 **Enhanced Collaborative Airport Performance Planning and Monitoring**	**N**	This solution will significantly participate to enhancing the predictability of airport operations and is expected to have a very positive impact on the Network side. Beyond, this solution is expected to close the work that has been done in SESAR 1 around AOP-NOP by: • Finalising the first consolidated set of AOP-NOP information sharing which would ultimately lead to European standardisation, • Ascertaining the benefits that would result on both sides (Airport and Network) if a large number of airports would then proceed to such deployment. • Fine tuning the minimum quality of information expected on both sides (Airport and Network) so that expected benefits can be delivered at European level. • Contributing to the development of an AOP-NOP information service under PJ.15 responsibility, to be validated in a SWIM environment.

SOLUTION PJ.04-02 **Enhanced Collaborative Airport Performance Management**	**N**	This solution further improves the accuracy of advanced planning by accommodating numerous variables and providing stakeholders with scenario testing in order to support CDM when there is a DCB imbalance. The collaborative action includes the NM and AU's and may need the communication with external stakeholders (AOC, NOP, etc.) in the "collaborative" environment. Airport performance strongly depends on the performance of the Network. MET impact on AOP could be due to MET conditions locally around the airport but also in a wider scope (data and information from MET services at Network level). Thunderstorms or strong (cross) wind conditions at neighbouring airports could impact other airport(s) due to large number of diversions or reduced/delayed traffic to affected airports. Furthermore MET impact assessment will support decision support tools in deriving optimal solutions in adverse weather conditions, triggering CDM actions between Airport and Network. Pro-active collaborative Airport/Network management of predicted performance deterioration implies communication between local Airport and the ATM Network. Airport Performance strongly depends on the performance of the Network. Management of predicted performance deterioration therefore needs to be aligned with the Network. Certain local actions/solutions will impact the Network performance and therefore needs to be coordinated with it. Knowing that the Network cannot prevent certain local actions/solutions of taking place the Network will need to be informed to reduce / mitigate the impact on the overall Network. Airport DCB, the element of the DCB solution described by PJ.09, is part of Airport Performance Management, which will be shared with Network through Solution PJ.04-01 and PJ.04-02.

Expected inputs to be considered

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

- SESAR 1 P06.03.01-D145 OFA 05.01.01 Final OSED
- SESAR 1 P06.03.01-D147 OFA 05.01.01 Final SPR
- SESAR 1 P06.03.01-D146 OFA 05.01.01 Final INTEROP
- SESAR 1 P12.06.02 D60 Phase 3 AOP Final Specification
- SESAR 1 P12.06.03 D14 TS Refinement
- SESAR 1 P12.06.07 D30 System requirements consolidation deliverable
- SESAR 1 P12.06.08 D19 Final Technical Specification
- SESAR 1 P12.06.09 D24 Phase 3 Final Specification
- SESAR 1 P12.07.03 D25 Phase 3 - APAMS Final Technical Specification
- SESAR 1 P12.07.05 D17 Final Improved Weather Information System Requirements
- SESAR 1 P15.04.09c D17 Technical Specification after v3 validation

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.04	
Source Project	**Source Solution**	**PJ.04-01 Enhanced Collaborative Airport Performance Planning and Monitoring**	**PJ.04-02 Enhanced Collaborative Airport Performance Management**
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA		▨
PJ.02 Enhanced Runway Throughput	PJ.02-09 Enhanced Runway Condition Awareness		▨
	PJ.02-08 Traffic optimisation on single and multiple runway airports		▨
PJ.07 Optimised Airspace Users Operations	PJ.07-02 AU Fleet Prioritization and Preferences	▨	
PJ.09 Advanced DCB	PJ.09-03 Collaborative Network Management Functions		▨
PJ.15 Common Services	PJ.15-01 Sub-regional Demand Capacity Balancing Service		▨
PJ.18 4D Trajectory Management	PJ.18-02 Integration of trajectory management processes in planning and execution		▨
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)		▨
SESAR1	#18 CTOT and TTA		▨
	#20 Collaborative NOP for Step 1	▨	▨
	#21 Airport Operations Plan and AOP-NOP Seamless Integration	▨	▨
	#46 Initial SWIM	▨	▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.02	PJ.07			PJ.09	PJ.18	
Source Project	**Source Solution**	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.09-03 Collaborative Network Management Functions	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-06 Performance Based Trajectory Prediction
PJ.04 Total Airport Management	PJ.04-01 Enhanced Collaborative Airport Performance Planning and Monitoring			▨			▨	
	PJ.04-02 Enhanced Collaborative Airport Performance Management	▨	▨	▨	▨	▨	▨	▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services, Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

PJ.04 will ensure its developments, in particular the KPI suite, are aligned with the SES Performance Scheme relevant to airports. PJ.04 will consider existing work being conducted into improvements in landside operations to facilitate integration into AOM.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

PJ.04-01 solution is expected to contribute to the standardisation of information sharing between AOP and NOP at European level.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (Airport, Network management),
    - ATM Operational Experience (Airport, Network Management),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - MET expertise,
    - AIM expertise.
- System:
    - System engineering and prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies.
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis.
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.5 High Performing Airport Operations – Remote Tower for Multiple Airports (PJ05)

PJ.05	Remote Tower for Multiple Airports

Problem Statement

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

- The maintenance and upkeep costs of old Tower facilities are inefficient and expensive.
- The relative cost of ATS is high 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).

SESAR 1 performed trials to figure out the possibility to perform ATS from 1 CWP (controller working position) to several connected airports in a remote tower module. Up to 3 airports were simulated during the V2 real-time simulations. The projects last trials had 2 small AFIS airports connected in a V3 passive shadow mode trial. Contingency trials aimed to find an operational solution as well as technical systems for provision of remote tower services in case of a closure of the ordinary tower at a medium sized airport.

The main work on validation side in SESAR 1 was done in the area of single tower. Multi Remote TWR especially parallel mode was only partly covered in validation exercises. Therefore there is still a gap between the status of SESAR 1 and request from the market regarding a highly efficient multi remote tower solution. This gap should be filled by PJ05 solutions to bring the multi remote tower operations to a higher maturity level and provide a baseline for implementations.

In addition, four demonstration activities in SESAR 1 addressed multiple remote tower services in varied traffic densities from which valuable lessons could be learnt.

Remaining work within Remote Towers

It is very important to maintain a service from small airports to metropolitan to keep rural and remote regions vivid and interesting for people to inhabit and industry to grow. Remote Tower Services (RTS) provide an opportunity for continued operation of airports and rural development.

An RTS solution also gives small/medium airports an easier way to expand technology related to safety in a cost efficient way. Note that B.05 in conjunction with OFA 06.03.01 estimated that multiple remote tower operations from a single centre could reduce the amount of ATCOs/AFISOs.

The first responsibility of Remote Tower Solutions is to validate that the effective provision of ATS to multiple remote sites is possible, and is at least as safe as current methods of service provision.

To further improve remote tower services for more than one airport, work to be addressed is different kind of environments in order to demonstrate the amount of airports to be controlled at one time, considering the mix of complexity, controller workload and type of traffic (VFR- IFR-mix, rotor-fixed wing, special, RPAS).

Technical aspects, such as network quality of service and other resilience/redundancy related issues that are of key importance to the regulatory authorities need to be addressed. Further development of the CWP (Controller Working Position) is required for a module more suitable for a centre with several CWPs. Maintenance cost and support costs can be lowered with standardized equipment compared to the large variety of environments in today’s towers. On job training would benefit from such equipment and costs can be lowered with a unified CWP.

The remote tower solution needs to look into possibilities to become SWIM-enabled, i.e. make use of standardised service interfaces for communication between the remote airport, CWPs (in Remote Tower Centre) and other ATM stakeholders such as En-route/Approach ATC, Airport operations and Airspace users. This will ensure that the remote tower solution follows the guidelines of the European ATM Architecture (EATMA) and allows the required flexible implementation, i.e. towers with different technical configurations can co-exist and evolve independently to satisfy changing operational needs.

Focus on 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. Such functionalities can cover e.g. voice recognition, alerting and warnings for conflict detection and conflict resolution advisories.

All these technical aspects need to be addressed to find and develop features and tools necessary for a multiple remote tower environment both regarding system redundancy as well as fall back options in standardized ways.

In some environments the need for enhanced visual surveillance tools might occur, which requires a seamless integration of air/ground multi-sensor tracking and other systems for situational awareness.

Situating the multiple remote tower providing ATS in Remote Tower Centres (RTCs) insures possibilities for more cost efficient solutions e.g. through flexible use of human resources.

Remote Tower Centre providing Remote Tower Services to a large number of airports with a flexible and dynamic allocation of airports connected to different Remote Tower Modules (RTM) over time will have a major impact on the cost reduction. There will be a need for effective planning tools in both short term and long term all managed by a supervisor role. The RTMs need also to support these advanced RTCs. This could also include a RTC to RTC coupling transferring responsibility of an airport.

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

The remote tower operations in contingency solutions ensure that ATC can provide safe ATS to maintain a high level of capacity in cases when normal tower operations are not available. In contrast to single remote tower operations (SDM-0201), in contingency operations, a high traffic volume needs to be controlled (not necessarily by just one controller as usually implemented for single remote tower.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

Solution PJ.05-02: Remotely Provided Air Traffic Service for Multiple Aerodromes

Solution PJ.05-03: Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.05-02: Remotely Provided Air Traffic Service for Multiple Aerodromes

Solution Description:

This SESAR Solution consists of:

- Providing:
  - Aerodrome Control Service or Aerodrome Flight Information Service for more than one aerodrome simultaneously from a remote location.
  - Further development of the CWP
- Met information from multiple airports

Aerodrome Control Service or Aerodrome Flight Information Service for more than one aerodrome is provided by a single ATCO/AFISO from a remote location, i.e. not from a control tower local to any of the aerodromes. The ATCO (or AFISO) in this facility performs the remote ATS for the concerned aerodromes.

The Remote Tower operational concept enables a cost effective and safe provision of Air Traffic Services (ATS) or other related services at several airports at a time by one controller from a control facility that is not located in the local ATS Tower. This also has a possibility to allow ATC or AFIS to very small remotely located airports.

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

Based on the results of SESAR 1 (V3 reached for **AFIS** on multiple airports for low density aerodromes), the multiple remote concept needs to be validated for several environments in order to demonstrate which type of and how many airports with how much traffic at a time can be controlled. Different combinations of 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 in a highly flexible way to several airports at a time. Unified CWPs has a large possibility to lower maintenance and support costs as well as reduce time spent on the job training (OJT). Integration of local tower CWP developments shall be considered.

Technical aspects, such as network quality of service requirements and other resilience/redundancy-related issues that are of key importance to the regulatory authorities shall be addressed by PJ05.

Furthermore, the information needs for maintaining situational awareness including the local actual and forecasted weather (MET) and the local actual and forecasted status of the infrastructure (AIM) will need to be addressed from various perspectives. Key considerations will be given to the definition of these information needs, to liaise with PJ18 to develop potential SWIM enabled MET and AIM capabilities to support these needs and to integrate this information into the CWP.

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

Training and licensing aspects will have to be considered.

Operating Environment:

Various types of airports and a variety of size and complexity regarding type of traffic (using shadow mode and live trials); specifics to be defined at an early stage when the project starts.

Importance for specific air user groups: with a RTS solution SESAR will give RPAS, GA, BA and Rotorcraft a larger access to remote regions in Europe.

List of OI steps and enablers:

Solution PJ.05-02 Remotely Provided Air Traffic Service for Multiple Aerodromes	Maturity				
	SESAR 1	SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
SDM-0207 “Remotely Provided Air Traffic Service for Multiple Aerodromes”	V2		V3		

Enabler Code	Enabler Title
AERODROME-ATC-54	Provide a Remote Tower Centre (RTC) position that enables one ATCO to control multiple remote towers simultaneously~~.~~
CTE-S02d	Video Surveillance

CTE-XXX	Enhanced VCS to support multiple remote tower modules					
ATC-52b	Provide Remote Controller Working Position with visual reproduction of several remote aerodrome views and other sensor data.					
ATC-53b	Controller Working Position enhanced with additional information for low visibility or night conditions at any of the aerodromes					
ATC-xxb	Provide the Multiple Remote Tower CWP with additional information that can be presented as overlays.					
METEO-03c	Provide controller with MET data including local weather for several remote aerodromes					
METEO-04c	Provide the Multiple remote tower CWP with weather forecasts for several airports at a time					
AIMS-xx	Provision of graphical briefing capability (AIM and MET) for Remote Tower Controller position					

NOTE : the list of enablers should be further updated in the frame of DS15

<u>Identification of CNS related needs</u>

- Provision of enhanced VCS to support controllers working remote in multiple controller working positions

<u>Identification of MET and AIM related needs</u>

- MET information needs
    - MET information requirements need to be detailed based on the situational awareness requirements established.
- AIM information needs
    - AIM information requirements need to be detailed based on the situational awareness requirements established.

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- The remote tower solutions need to look into possibilities to become SWIM-enabled, i.e. make use of standardised service interfaces for communication between the remote airports.
- SWIM enabled MET services

SESAR Solution PJ.05-03: Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules

<u>Solution Description:</u>

This SESAR Solution consists of:

- RTC supervisor and support systems for a more cost efficient solution e.g. through flexible use of human resources

- In some environments an integration of approach for airports connected to the remote centre need to be investigated and connections between RTCs with systems for flow management between remotely connected airports have to be considered.
- Development of tools and features for a flexible planning of all aerodromes connected to remote tower services.
- Advanced automation functions
- SWIM infrastructure

The Remote Tower operational concept enables the cost effective and safe provision of Air Traffic Services (ATS) or other related services at several airports at a time by one controller from a control facility that is not located in the local ATS Tower. This also has a possibility to allow ATC or AFIS to very small remotely located airports.

Remote Tower Centre (RTC) providing Remote Tower Services (RTS) to a large number of airports with a flexible and dynamic allocation of airports connected to different Remote Tower Modules (RTM) over time will have a major impact on the cost reduction. There will be a need for effective planning tools in both short term and long term all managed by a supervisor role. The RTMs need also to support these advanced RTCs. This could also include a RTC to RTC coupling transferring responsibility of an airport.

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/or supporting systems will be defined.

Technical aspects, such as network quality of service and other resilience/redundancy related issues that are of key importance to the regulatory authorities need to be addressed. Further development of the CWP (Controller Working Position) is required for a module more suitable for a centre with several CWPs. Maintenance cost and support as well as time for on job training can be lowered with a unified CWP.

The possibility to add several modules for remote tower services at a remote tower centre enables a flexible allocation of airports connected to the same facility. It will also improve the possibility to provide ATS for airports in remote regions or with a seasonal request of service.

Adding several modules at the same facility improves resilience by adding back up possibilities. Planning tools for shorter and longer term will ensure the possibility for a “supervisor” function to use the available RTMs in a safe and efficient way, both for multiple and single situations.

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.

Defining long / short term RTC planning tool(s) for operational management and to technically be able to move airports between Remote Tower Modules (RTM).

Defining of tools needed in a RTM for ATCOs controlling multiple airports, and especially when assigned a new airport. For example; how to handle a handover (planned and urgent), which technology support required.

Debriefing tool, a quick recap to ATCOs of what has happened recently

Defining of technical supervision for a large RTC

Deeper analysis of how to handle contingency situations in an RTC.

How to handle if a country has to close one of its two RTCs, or what happens if there is an RTC, what to do in a Contingency situation.

Training and licensing aspects, in particular in RTCs covering cross-border operations are elements that will have to be considered.

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

Operating Environment:

Small to medium airports, several airports connected to a site with several modules for remote air traffic service

Importance for specific air user groups: with a RTS solution SESAR will give RPAS, GA, BA and Rotorcraft a larger access to rural regions in Europe.

List of OI steps and enablers:

SOLUTION PJ.05-03 – Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules		**Maturity**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
SDM-0208 "Remote Tower Centre supported by short term planning"		V1		V2	V3	
ATC-xx	Short term planning tools for a remote tower centre with several controller working positions					
ATC-xx	Supervisor function, WS, for planning of a remote tower centre					
SDM-0209 "Remote Tower Centre supported by long term planning"		V1			V2	V3
ATC-yy	Long term planning tools to enable a more flexible usage of CWP and staffing for traffic as well as shift planning.					
ATC-yy	Technical supervision of several connected airports and controller working positions.					
SDM-0210 "Highly flexible allocation of aerodromes to controller working positions"		V1		V2		V3

ATC-52c	Provide Remote Tower Working position with visual reproduction of several remote aerodrome views and other sensor data.					
ATC-53c	Remote Tower Working position enhanced with additional information for low visibility or night conditions at any of the aerodromes					
ATC-xxc	Provide the Multiple Remote Tower CWP with additional information that can be presented as overlays.					
ATC-yyc	Provide the Remote Tower Controller Working Position with planning and sequencing tools as well as other enablers that are necessary for simultaneously ATS to multiple remote aerodromes.					
ATC-zzc	Automation functionalities for the Multiple Remote Tower CWP to reduce workload for the controller					

NOTE : the list of enablers should be further updated in the frame of DS15

Identification of CNS related needs

- Enhanced airport surveillance - e.g. integrating video surveillance in support of remote tower developments and ASMGCS

  Independent Non Cooperative Surveillance for airport surface using Video Surveillance (enabler CTE-S02d)

Identification of MET and AIM related needs

- MET information needs
  - MET information requirements need to be detailed based on the situational awareness requirements established.
- AIM information needs
  - AIM information requirements need to be detailed based on the situational awareness requirements established.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- SWIM infrastructure is required
- SWIM enabled MET services

Performance Goals

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

- 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.

- Better cost effectiveness can be reached through large scale operation with co-location of staff, management, training, etc.
- 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.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.05-02 **Remotely Provided Air Traffic Service for Multiple Aerodromes**		**L**			**L**	**M**			**M**			**H**
SOLUTION PJ.05-03 **Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules**		**L**	**M**		**L**	**M**			**M**			**H**

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION / RATIONALE
SOLUTION PJ.05-02 **Remotely Provided Air Traffic Service for Multiple Aerodromes**	**L**	Integration between different airports

SOLUTION PJ.05-03 **Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules**	**L**	Remote Tower Centre development

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.05-02: Remotely Provided Air Traffic Service for Multiple Aerodromes.

Solution PJ.05-03: Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules.

- SESAR 1 P06.08.04-D94- 6.8.4 OSED Single Remote TWR Ph2 - Final Update
- SESAR 1 P06.08.04-D103- 6.8.4 Multiple Remote Advanced - OSED Update (6.9.3 D04)
- SESAR 1 P06.09.03-D35- Final OSED
- SESAR 1 P12.04.07 D09 Remote tower specifications - final Consolidated DEL
- SESAR 1 P12.04.06 / 12.04.08 final deliveries

Dependencies

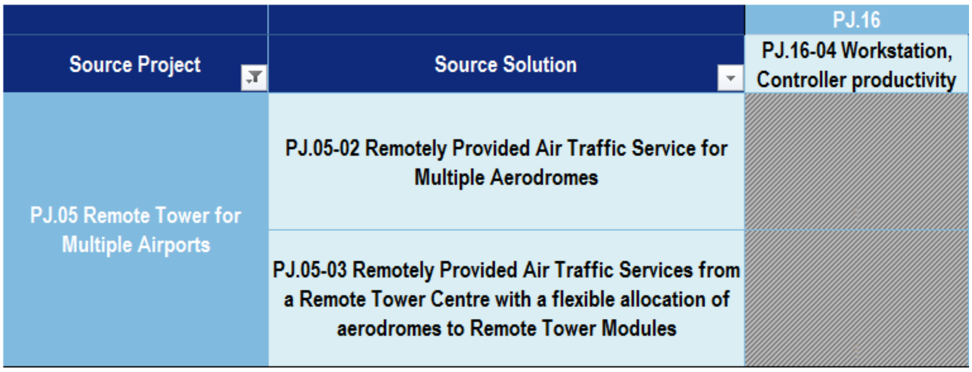
Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.05	
Source Project	Source Solution	PJ.05-02 Remotely Provided Air Traffic Service for Multiple Aerodromes	PJ.05-03 Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity	▨	▨
PJ.18 4D Trajectory Management	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)		▨
SESAR1	#12 Single Remote Tower operations for medium traffic volumes		▨
	#46 Initial SWIM	▨	▨
	#52 Remote Tower for multiple low density aerodromes	▨	

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.



		PJ.16
Source Project	Source Solution	PJ.16-04 Workstation, Controller productivity
PJ.05 Remote Tower for Multiple Airports	PJ.05-02 Remotely Provided Air Traffic Service for Multiple Aerodromes	▨
	PJ.05-03 Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules	▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

None at the present time

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

- EUROCAE WG-100
- EASA RMT 0624
- ICAO 4444 (visual observation and use of ASMGCS/Surveillance.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc.

for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (Airport, TMA),
    - ATM Operational Experience (Airport, TMA),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - MET expertise,
    - AIM expertise.
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Data link / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Program objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
- Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.6 Optimised ATM Network Services – Optimised Airspace User Operations (PJ07)

PJ.07	**Optimised Airspace Users Operations**

Problem Statement

The current ATM environment based on static flight plans (Time-based operations) is evolving through SESAR towards a Trajectory Based environment in order to improve Airports and ATM Network performance. Better performance of ATM operations depends on a better knowledge of the true demand in order to improve planning and operations and on better adherence to the plan during operations.

Airspace Users' decision processes and resulting business priorities differ from AU to AU and from flight to flight within one AU. The trajectory development and management processes in ATM currently do not allow each individual user to incorporate specific aircraft/flight priorities (developing from internal FOC/WOC decision-making) into the requested trajectory, and respect any constraint in a way that best meets the business priorities. Similarly, OAT flight plans are not harmonised at European level and information is not disseminated into the Network, this induces a lack of awareness about military traffic intentions that can impact ATM Network performance (including safety), and a lack of flexibility in the definition of cross-borders exercises and limitations in terms of interoperability.

Irregular operations impose unplanned/additional cost on airlines and have a huge impact on airlines' annual costs and revenue. Today the ATM system allows little flexibility to Airspace Users (e.g. ATFM slot swapping process). A better recovery process that includes more flexibility i.e. the ability of the ATM system to follow AUs' decision processes and accommodate AUs' changing business priorities, could result in substantial reductions of these impacts. Flexibility and equity in the ATM system are key.

SESAR 1 has increased AUs' flexibility to reduce their costs in face of delays with the early User Driven Prioritisation Process (UDPP) developments:

- if delays occur due to ATFM Regulations, they have the possibility to request the swap for two flights involved in the same Most Penalising Regulation: the possibilities have now been enhanced (Enhanced ATFM slot swapping ESS);
- The AOP concept from SESAR captures AU prioritisations for incorporation into the Airport DCB and sequencing processes.

Beyond swapping, Airspace Users' full participation through their FOC/WOC into ATM Collaborative Processes, including flights' prioritisation with the full UDPP processes, is essential to minimise impacts of deteriorated operations for all stakeholders including AUs.

The FOC/WOC can provide a sound interface to ATM taking into account several of AU performance drivers in their interaction with ATM processes. SESAR already proposes significant improvements on the FOC/WOC integration with ATM Network through the FOC/WOC/Network/ATC increased and improved sharing of operational data (Extended Flight Plan, improved OAT Flight Plan, tools allowing more flexible use of Airspace – AFUA, use of additional MET information that is made available to AU flight planning/dispatchers).

However, with regard to the current ICAO approach on the establishment of a collaborative environment (ICAO Doc. 9965) as well, where one of the fundamental principles is the primacy of the Airspace Users' requests provided the optimum system outcome is not compromised, further operational improvements need to be implemented in order to better integrate Airspace Users into the future TBO- and CDM-based ATM environment, to the benefit of the broader ATM system.

Specifically:

- a full acknowledgement of the role and of the decision processes of FOC/WOC, and
- a full specification of the workflows and interactions of FOC/WOC in the intended Trajectory Based Operations and CDM-based ATM environment,

are regarded as key factors. The collaborative planning and flight execution processes shall be performed at “level playing field”, i.e. that performance of all actors is taken into consideration (including performance degradation in case of flight operation in capacity constrained situations). Rules must be implemented in case no collaborative planning is possible; such rules may consist of pre-agreed criteria for flight prioritization and airline network optimization (e.g. who will take the final decision). AUs need to speak with one voice: PJ07 is the AUs’ requirements for managing their interaction with the other actors in ATM in the CDM processes in SESAR.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019

Project Optimised Airspace Users Operations (OAUO) consists of the following high level topics, structured through four main SESAR Solutions:

1 – **Airspace Users’ Processes for Trajectory Definition**

This Solution includes and addresses one of the three major areas of development for the Airspace Users in future ATM: the FOC related processes for the management of the Shared Business Trajectory.

This item responds to the need to accommodate individual AU’s business needs and priorities without compromising optimum ATM system outcome and the performances of all stakeholders, through a full integration of the FOC within the ATM system. It aims to:

- Develop requirements and validate procedures and workflows for FOC to interact with other ATM stakeholders with regard to trajectory definition (long and short term), and to ensure continuity in the CDM process throughout the trajectory life-cycle
- Provide the ATM Network with the most accurate input on the true demand at any time (planning phase) and to get from ATM Network an improved, harmonised picture of the ATM constraints (including MET and Aeronautical information) for evaluating their impact on operations

R&D goals include:

- Full integration of FOCs in the ATM Network processes
- Increase FOCs role with regard to the Trajectory Management in future ATM (in planning and execution phase);
- Investigate the impact of such integration on all concerned ATM actors performance: FOC, Network, Airport and ATC.

2 – **Airspace Users' Fleet Prioritisation and Preferences (UDPP)**

This Solution includes and addresses the second major area of development for the Airspace Users in future ATM: the possibility to submit a priority order request through the User Driven Prioritization Process (UDPP), and to share Preferences with the other ATM stakeholders in Capacity Constrained Situations (CCS) and also in circumstances when there is no demand capacity imbalance.

UDPP is the Airspace Users' input into the ATM Network CDM processes when flights need to be prioritised. It allows more flexibility to them for anticipating delays on departure, en-route and arrival in a consistent way with the Airports and NM actors.

The processes, methods and tools by which airspace users (AUs) can indicate to the other stakeholders (Airports, NM, other AUs, ANSPs) their prioritization requests in a Collaborative Decision Making environment need to be elaborated.

The UDPP High-Level Principles and Rules include Transparency, access to all AUs on a voluntary basis following pre-existing agreement, no negative impact to other stakeholders, recordings, monitoring against abuse/misuse form the UDPP Charter framing the behaviour of participating AUs. Implementation of UDPP concept and services will explore the possibility to use B2B services in a SWIM-enabled network environment (NOP).

The UDPP Concept (i.e. the basis for the SESAR 1 P07.06.02 D79 Step 2 V2 UDPP FINAL OSED) includes several non-mandatory possibilities for prioritising flights in addition to those validated in SESAR, aiming to cover most situations for most categories of Airspace Users:

- Selective Flight Protection;
- Fleet Delay Assignment (e.g. FF-ICE Operator Flight Priority);
- UDPP extended for Business Aviation, General Aviation and Helicopters;
- Re-planning during Execution;
- Incentive-UDPP (proposed as an Exploratory Research topic);

R&D goals include:

- Smooth integration of AU Preferences in collaborative processes at Airports and in Network DCB processes (in terms of processes, data, timing, constraints management, what-if analysis capabilities taking into account the performance of the airport), allowing multi-criteria optimization task involve many stakeholders, e.g. combining A-MAN, S-MAN and D-MAN.
- Potential contribution to transversal improvements such as TTA management that will require an overall coordinated approach
- New performance indicators reflecting AUs' business needs in the ATM performance scheme
- Technology that drastically reduces the need for Airspace Users to intervene through labour intensive (manual/telephone) coordination (high level of automation): critical for integrated processes to work on an operational scale.

As the level of flexibility to prioritise flights in UDPP depends on the volume of traffic, this SESAR Solution aims also at developing and validating the concept of providing opportunities in UDPP to all Airspace Users that have little whilst regular traffic volume at a given airport - typically Business Aviation, General Aviation and Helicopters - that can easily avoid capacity constraints situations (CCS) and occasionally need access to airport even at busy periods, should also be part of UDPP.

3 – **Mission Trajectory Driven Processes**

This Solution responds to the need to accommodate individual Military AU's needs and priorities without compromising optimum ATM system outcome and the performances of all stakeholders, through a full integration of the WOC within the ATM system. It aims to:

- Develop requirements and validate procedures and workflows for WOC to interact with other ATM stakeholders with regard to mission trajectory definition (long and short term) and execution, and to ensure continuity in the CDM process throughout the trajectory life-cycle
- Provide the ATM Network with the most accurate input on the true demand at any time (from planning to execution phases) and to get from ATM Network an improved, harmonised picture of the ATM constraints (including MET and Aeronautical information) for evaluating their impact on operations
- Develop a Pan-European OAT-IFR Transit Service (OATTS) which connects national structures and delivers a flexible service facilitating OAT-IFR flights across Europe: OATTS provides timely and flexible availability of adequate routing and services to military mission for short transit into military training/exercise areas, and long-haul transit across States. Additionally, pre-defined scenarios will be available to facilitate increased military OAT transit demands in the event of large-scale military operations and exercises (ATM Contingency Plans)

R&D goals include:

- Full integration of WOCs in the ATM Network processes
- increasing WOC role with regard to the Mission Trajectory Management in future ATM (in planning and execution phase);
- investigate the impact of such integration on all concerned ATM actors performance: WOC, Network, Airport and ATC

4 – **Airspace Users' Trajectory Execution from FOC perspective**

This Solution includes and addresses the third major areas of development for the Airspace Users in future ATM: the FOC related processes for the management of the Reference Business Trajectory.

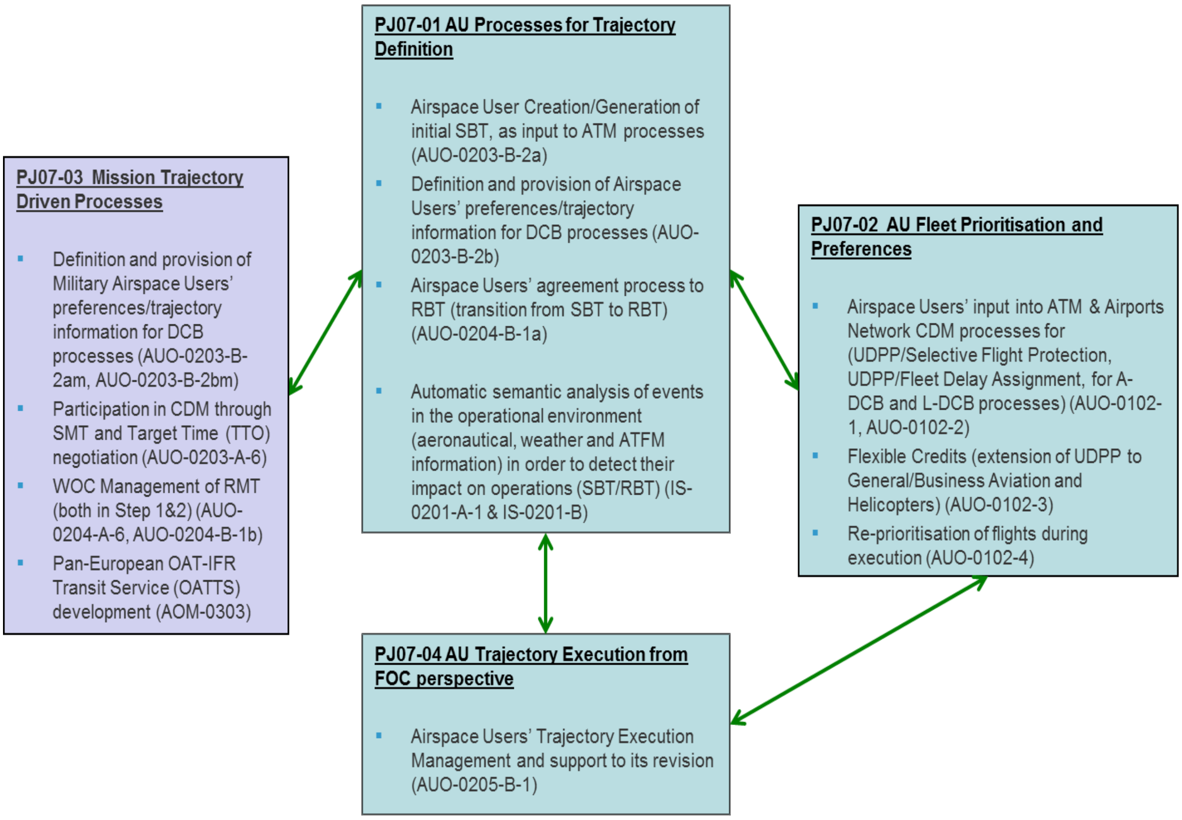
This item responds to the need to accommodate individual AU's business needs and priorities without compromising optimum ATM system outcome and the performances of all stakeholders, through a full integration of the FOC within the ATM system. It aims to:

- Develop requirements and validate procedures and workflows for FOC to interact with other ATM stakeholders with regard to trajectory execution, and to ensure continuity in the CDM process throughout the trajectory life-cycle
- Clearly identify, define and allocate roles and responsibilities between the FOC and the cockpit crew for managing the trajectory execution and supporting its revision process with other ATM stakeholders;
- Provide the ATM Network with the most accurate input at any time (execution phases) and to get from ATM Network an improved, harmonised picture of the ATM constraints (including MET and Aeronautical information) for evaluating their impact on operations

R&D goals include:

- Full integration of FOCs in the ATM Network processes
- Increase FOCs role with regard to the Trajectory Management in future ATM, in execution phase;
- Investigate the impact of such integration on all concerned ATM actors performance: FOC, Flight Crew, Network, Airport and ATC.

The links between the four Solutions are showed in the following figure:



PJ07-01 AU Processes for Trajectory Definition

- Airspace User Creation/Generation of initial SBT, as input to ATM processes (AUO-0203-B-2a)
- Definition and provision of Airspace Users' preferences/trajectory information for DCB processes (AUO-0203-B-2b)
- Airspace Users' agreement process to RBT (transition from SBT to RBT) (AUO-0204-B-1a)
- Automatic semantic analysis of events in the operational environment (aeronautical, weather and ATFM information) in order to detect their impact on operations (SBT/RBT) (IS-0201-A-1 & IS-0201-B)

PJ07-03 Mission Trajectory Driven Processes

- Definition and provision of Military Airspace Users' preferences/trajectory information for DCB processes (AUO-0203-B-2am, AUO-0203-B-2bm)
- Participation in CDM through SMT and Target Time (TTO) negotiation (AUO-0203-A-6)
- WOC Management of RMT (both in Step 1&2) (AUO-0204-A-6, AUO-0204-B-1b)
- Pan-European OAT-IFR Transit Service (OATTS) development (AOM-0303)

PJ07-02 AU Fleet Prioritisation and Preferences

- Airspace Users' input into ATM & Airports Network CDM processes for (UDPP/Selective Flight Protection, UDPP/Fleet Delay Assignment, for A-DCB and L-DCB processes) (AUO-0102-1, AUO-0102-2)
- Flexible Credits (extension of UDPP to General/Business Aviation and Helicopters) (AUO-0102-3)
- Re-prioritisation of flights during execution (AUO-0102-4)

PJ07-04 AU Trajectory Execution from FOC perspective

- Airspace Users' Trajectory Execution Management and support to its revision (AUO-0205-B-1)

The FF-ICE concept will be also integrated in the Trajectory Planning, Tactical and UDPP processes. It is a concept addressing the requirements for future flight plans in a way Airspace Users can provide more information on their flights to the global ATM, seamlessly exchanged, and offers also the opportunity to provide the ATM with an indication of the relative priorities and preferences of a flight within an operator's set of flights (e.g. fleet); these priorities and preferences must be complied with by the ATM Service Provider, but meeting overall system performance takes precedence over them. Additional Airspace User constraints and preferences may be best expressed within the trajectory information sharing.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the

interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

In order to contribute to the development and integration of SESAR Step 2 and FF-ICE Concepts, the Solutions proposed in this DOW may be subject to improvements and modifications by the definition of new OIs and/or the exchange of current ones between them. The mechanisms developed shall be compatible with the 4D trajectory management mechanisms.

More detailed description can be found in the ICAO/ATMRPP material on FF-ICE (*Flight & Flow - Information for a Collaborative Environment)*.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.07-01: AU Processes for Trajectory Definition

Solution Description:

Based on the description of this Solution, the following Operational Improvements have been identified and described in order to define the scope of the project:

- **AUO-0207** : User preferences associated to meteo

  The SBT will be fully implemented and its content will be harmonized with the future ICAO FF-ICE provisions. The SBT will reflect the trajectory options for available meteorological scenarios/forecasts and - as made available by the individual AU - relevant business needs and priorities

- AUO-0208 : Provision of user preferences and trajectory information for DCB processes

  The SBT encompasses complete description of Flight intention, flight profile including for military, any reference to airspace reservation/restriction (ARES) needs. The SBT flight information environment will be highly interoperable and will support the exchange of information as detailed as the SBT data elements. All participants of the SBT flight information environment will be connected via the SWIM network

- AUO-0209 : FOC agreement on RBT

  The RBT will be fully implemented, as the result of the collaborative planning process that updates the SBT. The switch from SBT to RBT is a transition of the trajectory status, from "Shared" to "Reference". The RBT will include tolerances that will be used as a trigger for

ATM ground systems to identify coordination needs including Network Management. The RBT will also include data elements that will facilitate the dynamic DCB, airspace management and airport functions. The RBT flight information environment will be highly interoperable and will support the exchange of information as detailed as the RBT data elements. All participants of the RBT flight information environment will be connected via the SWIM network

- IS-0207 : Automated semantic analysis of digital aeronautical and weather information updated

  The availability of fully digital weather data and aeronautical data, including dynamic updates, will enable the automatic real-time detection of significant events and the evaluation of their impact on the operations. Semantic analysis techniques can fine tune this detection and impact analysis process, to the needs of each particular user, taking into consideration the Airspace Users characteristics and preferences

The lists of Enablers below, associated to each proposed OIs, have to be considered a baseline as outcome of an initial analysis performed on the current Master Plan (Data Set 13 OIs and Enablers). Further research is expected to be performed within S2020 for improving and finalising these lists.

The project will also include the definition of technical specifications and development of supporting functionalities for the future FOC (e.g. dynamic integration of ATM constraints into the flight planning tools), their verification and integration with SWIM Infrastructure allowing all AU to plan and execute the most efficient Business Trajectory in line with their performance requirements.

<u>List of OI steps and enablers:</u>

<table>
<tr><th rowspan="4">SESAR Solution PJ.07-01
AU Processes for Trajectory Definition</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AUO-0207 "SBT including user preferences associated to meteo
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-11</td><td>Integration of constraints and answers</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
</table></td><td>V1</td><td colspan="3">V2</td><td>V3</td></tr>
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AUO-0208 "SBT including user preferences and trajectory information for DCB processes"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-11</td><td>Integration of constraints and answers</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
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<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
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AUO-0209 "FOC agreement on RBT"

<table>
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<tr><td>AOC-ATM-11</td><td>Integration of constraints and answers</td></tr>
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<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
</table>

</td>
<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
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<td>

IS-0207 "Automated semantic analysis of digital aeronautical and weather information updated"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIMS-23</td><td>Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements</td></tr>
<tr><td>AIMS-24</td><td>Provide semantic analysis capabilities.</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
</table>

</td>
<td>V2</td><td></td><td>V3</td><td></td><td></td>
</tr>
</table>

Identification of CNS related needs

- See dependencies section.

Identification of MET and AIM related needs

- MET information needs
    - MET information for AU flight Operations and for all stakeholders involved in UDPP including information to support: de-icing process and all other operational aspects that require planning from 3 days to 2 hours before departure
    - Further MET information requirements need to be detailed based on operational integration requirements established

- AIM information needs
    - AIM information requirements need to be detailed based on operational integration requirements established

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- The Solution requires SWIM services (to be further developed)

SESAR Solution PJ.07-02: AU Fleet Prioritization and Preferences (UDPP)

Solution Description:

Based on the description of this Solution, the following Operational Improvements have been identified and described in order to define the scope of the project. It is intended to further develop the concept to sharing preferences with the other ATM stakeholders and to allow prioritisation in all cases for reasons of AU Business interest.

- AUO-0104Selective Flight Protection (SFP)

  In case of deteriorated operations due to reduced capacity in the planning phase, airspace users can recommend to the network management function and appropriate airport authorities a priority order request for flights affected by delays on departure, arrival and en-route with the Selective Flight Protection (SFP) feature by using Operating Credits. The network management function or appropriate airport in charge of the imbalance publishes an Operating Index reflecting the reduced capacity; it corresponds to the number of Operating Credits that a flight needs in order to fly close-to on-time during the reduced capacity period. In order to protect important flights Airspace Users need to take the Operating Credits from other flights by putting those flights out of the congested period. SFP changes in the priority order are introduced at the request of airspace users; there is no obligation for Airspace Users to use SFP if there is no AU Business interest.

- AUO-0105Fleet Delay Assignment (FDA)

  In the planning phase, airspace users can recommend to the network management function and appropriate airport authorities a priority order request for flights if they are affected by delays on departure, arrival and en-route with the Fleet Delay Assignment (FDA) feature. The relative priority of flights in an AU's fleet can be set in the trajectories planning using the Fleet Prioritisation Preference field. In case of deteriorated operations due to reduced capacity, the network management function or appropriate airport in charge of the imbalance publishes an Operating Index reflecting the reduced capacity. Airspace Users can then modify the FDA priority of its flights involved in the reduced capacity period to adapt to the situation. The network management function or appropriate airport apportions the total delay of each carrier's flights involved according to the FDA priority value. FDA changes in the priority order are introduced at the request of airspace users, and there is no obligation for them Airspace Users to use FDA if there is no AU Business interest.

- AUO-0106 : Re-prioritising during Execution

  In case of delays in execution on En-route or on Arrival for flights in the scope of d-DCB, airspace users can recommend to the network management function and appropriate airport authorities, a priority order request for flights affected by delays on arrival and en-route using a sub-set of the FDA and SFP features to be defined aiming at equity and taking into account the very limited flexibility available in execution. Requests for change in the priority order could be introduced at the initiative of airspace users, and upon their control the network management function or the relevant airport authority.

- AUO-0107 :Flexible Credits

  In case of deteriorated operations due to reduced capacity in the planning phase, Airspace Users that have little whilst regular traffic volume at a given airport -typically Business Aviation, General Aviation and Helicopters - can recommend to the appropriate airport authorities a priority order request for flights affected by delays on departure and arrival with the Flexible Credits feature built upon the Operating Credits feature on one hand and their inherent ability to adapt their operations on the other hand. Those operators accumulate Flexible Credits when they avoid a reduced capacity situation that they would be allowed to use occasionally in a later SFP situation at the same place. Flexible Credits changes in the priority order are introduced at the request of airspace users; there is no obligation for them to use Flexible Credits if there is no AU Business interest.

The lists of Enablers below, associated to each proposed OIs, have to be considered a baseline as outcome of an initial analysis performed on the current Master Plan (Data Set 13 OIs and Enablers). Further research is expected to be performed within S2020 for improving and finalising these lists.

The project will also include the definition of technical specifications and development of supporting functionalities, their verification and integration with SWIM Infrastructure allowing all AU to plan and execute the most efficient Business Trajectory in line with their performance requirements.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SESAR Solution PJ.07.02
AU Fleet Prioritization and Preferences (UDPP)</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
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<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AUO-0104 "Selective Flight Protection"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
<tr><td>NIMS-25</td><td>Integration of Airport CDM data into Network DCB sub-system</td></tr>
</table></td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>AUO-0105 "Fleet Delay Assignment"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-48</td><td>Advanced Airport UDPP integrated with AOP Monitoring</td></tr>
<tr><td>AOC-ATM-18</td><td>FOC adaptation to support UDPP</td></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
<tr><td>NIMS-44</td><td>Evolution of NIMS to support management of UDPP</td></tr>
</table></td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
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<tr><td>PRO-095</td><td>Airline Operational Procedures for modifying RBT including agreed TTA to accommodate selected priorities</td></tr>
<tr><td>PRO-096</td><td>Airline Operational Procedures for modifying SBT including agreed TTA to accommodate selected priorities</td></tr>
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<td>
AUO-0107 "Flexible Credits"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-05</td><td>Airport UDPP integrated with AOP Monitoring</td></tr>
<tr><td>AOC-ATM-17</td><td>UDPP Departure system for FOC</td></tr>
<tr><td>AOC-ATM-18</td><td>FOC adaptation to support UDPP</td></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
<tr><td>NIMS-25</td><td>Integration of Airport CDM data into Network DCB sub-system</td></tr>
<tr><td>NIMS-44</td><td>Evolution of NIMS to support management of UDPP</td></tr>
<tr><td>PRO-095</td><td>Airline Operational Procedures for modifying RBT including agreed TTA to accommodate selected priorities</td></tr>
<tr><td>PRO-096</td><td>Airline Operational Procedures for modifying SBT including agreed TTA to accommodate selected priorities</td></tr>
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<td>Not addressed</td><td></td><td>V1</td><td></td><td>V2</td>
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<td>
AUO-0106 "Re-prioritising flights during Execution"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIRPORT-48</td><td>Advanced Airport UDPP integrated with AOP Monitoring</td></tr>
<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
<tr><td>NIMS-25</td><td>Integration of Airport CDM data into Network DCB sub-system</td></tr>
<tr><td>NIMS-44</td><td>Evolution of NIMS to support management of UDPP</td></tr>
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<td>Not addressed</td><td></td><td>V1</td><td></td><td>V2</td>
</tr>
</table>

Identification of CNS related needs

- See dependencies section.

Identification of MET and AIM related needs

- MET information needs
    - MET information for AU flight Operations and for all stakeholders involved in UDPP including information to support: de-icing process and all other operational aspects that require planning from 3 days to 2 hours before departure

  - Further MET information requirements need to be detailed based on operational integration requirements established
- AIM information needs
  - AIM information requirements need to be detailed based on operational integration requirements established

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- PJ.07-02 UDPP shall be supported by SWIM services

SESAR Solution PJ.07-03: Mission Trajectory Driven Processes

Solution Description:

Based on the description of this Solution, the following Operational Improvements have been identified and described in order to define the scope of the project:

- AOM-0303: Pan-European OAT Transit Service

  A pan-European OAT-IFR Transit Service (OATTS) is in place, which connects national structures and delivers a flexible service facilitating OAT-IFR flights across Europe. OATTS provides timely and flexible availability of adequate routing and services to military mission for short transit into military training/exercise areas, and long-haul transit across States. Additionally, pre-defined scenarios are available to facilitate increased military OAT transit demands in the event of large-scale military operations and exercises (ATM Contingency Plans)

- AUO-0210: Participation in CDM through SMT and Target Time (TTO) negotiation

  Data describing MT profile will be shared via the improved OAT Flight Plan in the medium/short term planning phase as a representation of SMT. The data included in the SMT will contain ATM related information specific to military mission objectives. The SMT will be progressively refined as time moves towards the execution phase and latest information affecting the flight becomes available. The sharing of these data may trigger the CDM process in order to balance the specific MT requirements with the BT requirements. The iterative negotiation process may result in the identification of a recommended Target Time in order to satisfy the ATM network performance expectations.

- AUO-0211: WOC Management of RMT

  The transition between SMT and RMT will be performed by WOC at a certain moment in time defined at the national level, beyond which any additional negotiation process may jeopardise the accomplishment of the mission. RMT will be published by WOC in NOP and will contain the 3D profile, ATM specific data, agreed upon CDM target times and associated tolerances. As soon as SMT becomes RMT, the revision process of RMT can also be initiated by WOC if needed. WOC will revise the RMT in the execution phase through the management of the improved OAT FPL. The revised RMT will be communicated by WOC to NM in order to be published in NOP.

- AUO-0212: WOC Management of RMT in Step 2

  In the trajectory based operations environment, RMT will be the result of the collaborative layered planning process and published in NOP. The RMT data are managed by WOC via SWIM and negotiated through the CDM process with the Network Manager. RMT will contain ATM constraints and targets. Military specific requirements for ARES DMA type will be part of trajectory profile in most of the cases and will be described in 4D data. RMT will be subject to update and revision processes, triggered either by WOC, Flight Crew or NM Function, and published in NOP.

- AUO-0213 : Military User preferences associated to meteo

  WOC will collect in the medium/short term planning phase, using the SWIM profile or other ground and airborne sources, meteo data and will integrate them into the trajectory profile definition for SMT. Based on this meteo information and other ATM related data, WOC will identify one or several geographical locations for the trajectory profile part/s associated to the ARES DMA type, satisfying the mission requirements and considering the least impact of the meteo phenomena on the mission execution.

- AUO-0214: Provision of Military user preferences and mission trajectory information for DCB processes

  WOC will develop several trajectory profiles for each mission, taking into consideration the operational requirements, the meteo data and other ATM constraints. The trajectory profile best suiting the mission objectives will be shared by WOC with NM and may be subject to CDM process. After several possible iterations, WOC defines upon the CDM process with NM the trajectory profile best suiting in the same time the mission requirements and the network performance expectations, incorporating ATM constraints and targets if necessary. This SMT is the representation of the Mission Requested Trajectory and will be integrated without any modifications into the DCB process, as part of the airspace configuration scenario published in NOP.

The lists of Enablers below, associated to each proposed OIs, have to be considered a baseline as outcome of an initial analysis performed on the current Master Plan (Data Set 13 OIs and Enablers). Further research is expected to be performed within S2020 for improving and finalising these lists.

The project will also include the definition of technical specifications and development of supporting functionalities for the future WOC, their verification and integration with SWIM Infrastructure allowing Military AU to plan and execute the most efficient Mission Trajectory in line with their performance requirements

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.07-03
Mission Trajectory Driven Processes</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AOM-0303 "Pan-European OAT Transit Service"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-72</td><td>Use of FMS/MMS data base to support mission trajectory</td></tr></table></td><td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
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<table>
<tr><td>AAMS-10a</td><td>Initial airspace management system enhanced with commonly applied GAT/OAT handling</td></tr>
<tr><td>AIMS-06</td><td>Ground-Ground AIS provision to ASM</td></tr>
<tr><td>AIMS-19b</td><td>Aeronautical Information system is interfaced to receive and distribute aeronautical information electronically to military systems.</td></tr>
<tr><td>AOC-ATM-14</td><td>Upgrade of WOC system to handle improved OAT flight plans</td></tr>
<tr><td>ER APP ATC 143</td><td>Upgrade of ATC System to handle Improved OAT Flight Plan</td></tr>
<tr><td>MIL-0501</td><td>Specifications for the interoperability of military ground systems with SWIM</td></tr>
<tr><td>MIL-0502</td><td>Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks</td></tr>
<tr><td>MIL-STD-01</td><td>Trajectory management and improved navigation</td></tr>
<tr><td>MIL-STD-02</td><td>Vertical navigation for fighter aircraft</td></tr>
<tr><td>MIL-STD-03</td><td>Update of IFPS User Manual to include OAT Specificities in the Flight Plan (Improved OAT flight plan)</td></tr>
<tr><td>MIL-STD-04</td><td>Procedure to implement EUROAT rules.</td></tr>
<tr><td>NIMS-35</td><td>Flight Planning management sub-system enhanced to process improved OAT flight plans</td></tr>
<tr><td>PRO-014</td><td>Procedures harmonised at pan-European level for the management of the Improved OAT FPL (flight plan filing, validation, acceptance and distribution)</td></tr>
<tr><td>PRO-015</td><td>Harmonised ATC Procedures for providing a standardized service to OAT flights at pan-European level</td></tr>
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AUO-0210 "Participation in CDM through iSMT and Target Time (TTO) negotiation"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-14</td><td>Upgrade of WOC system to handle improved OAT flight plans</td></tr>
<tr><td>AOC-ATM-20</td><td>Sharing of trajectory data between AOC/WOC and the ATM world using B2B web services</td></tr>
<tr><td>METEO-06b</td><td>Generate and provide MET information relevant for Network related operations, Step 1</td></tr>
<tr><td>MIL-0106</td><td>Wing Operations Centre Mission Support System enhanced to support the CDM process</td></tr>
<tr><td>NIMS-35</td><td>Flight Planning management sub-system enhanced to process improved OAT flight plans</td></tr>
<tr><td>NIMS-45</td><td>Initial Flight Planning management enhanced to support initial Mission</td></tr>
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<td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td>
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<tr><td></td><td>Trajectory</td></tr>
<tr><td>PRO-076</td><td>Procedures for the iSMT in the CDM process</td></tr>
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<td>
AUO-0211 "WOC Management of iRMT via improved OAT FPL"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-20</td><td>Sharing of trajectory data between AOC/WOC and the ATM world using B2B web services</td></tr>
<tr><td>GGSWIM-26a</td><td>Provision and use of Ground-ground data services for Network Operations Planning</td></tr>
<tr><td>MIL-0103</td><td>Wing Operations Centre Mission Support System (including update/revision) of iMT</td></tr>
<tr><td>NIMS-45</td><td>Initial Flight Planning management enhanced to support initial Mission Trajectory</td></tr>
<tr><td>PRO-077</td><td>Procedures facilitating iRMT management</td></tr>
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AUO-0212 "WOC Management of RMT"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIMS-23</td><td>Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements</td></tr>
<tr><td>MIL-0107</td><td>Wing Operations Centre Mission Support System (including update/revision) of MT in Trajectory Based Operations environment</td></tr>
<tr><td>PRO-078</td><td>Procedures facilitating iRMT management in Trajectory Based Operations environment</td></tr>
<tr><td>SWIM-APS-12</td><td>Provision and Consumption of Mission Trajectory exchange services (not using FO)</td></tr>
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<td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td>
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AUO-0213 "SMT including military user preferences associated to meteo"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>MIL-0104</td><td>Input of meteo data into the Wing Operations Centre Mission Support System</td></tr>
<tr><td>PRO-079</td><td>Procedures for the calculation of trajectory profile and ARES geographical location taking MET data</td></tr>
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AUO-0214 "SMT including user preferences and mission trajectory information for DCB processes"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>SWIM-APS-13</td><td>Ground-ground SWIM enabled services for MT data facilitating DCB</td></tr>
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<td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td>
</tr>
</table>

<u>Identification of CNS related needs</u>

- See dependencies section.

<u>Identification of MET and AIM related needs</u>

- MET information needs
  - MET information for AU flight Operations and for all stakeholders involved in UDPP including information to support: de-icing process and all other operational aspects that require planning from 3 days to 2 hours before departure
  - Further MET information requirements need to be detailed based on operational integration requirements established
- AIM information needs
  - AIM information requirements need to be detailed based on operational integration requirements established

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- None

SESAR Solution PJ.07-04: AU Trajectory Execution from FOC perspective

Solution Description:

Based on the description of this Solution, the following Operational Improvements have been identified and described in order to define the scope of the project:

- AUO-0206 : FOC Management of the Reference Business Trajectory

  This OI Step covers the accommodation of AUs' business drivers, needs and priorities (AU's optimised operations) as they change during the execution of trajectories, provided the optimum system outcome is not compromised. From the FOC perspective, it covers the management and the contribution to the update of the RBT. When the Agreed 4D trajectory is not the Airspace User (FOC) desired one, the ATM Service Providers will seek to provide the desired 4D trajectory as soon as possible. This has a corresponding requirement on the Airspace User (the FOC) to ensure that the desired 4D trajectory is kept updated. The sharing of the RBT contents will be based on identification of all relevant actors during the execution phase, from publication to termination on completion of the flight. FOC will support - time permitting - the Flight Crew during flight execution. It also addresses the consistency check made by the ground of the down linked airborne trajectory with respect to the ground trajectory as well as the synchronization of the ground trajectory with the airborne trajectory

The lists of Enablers below, associated to each proposed OIs, have to be considered a baseline as outcome of an initial analysis performed on the current Master Plan (Data Set 13 OIs and Enablers). Further research is expected to be performed within S2020 for improving and finalising these lists.

The project will also include the definition of technical specifications and development of supporting functionalities for the future FOC (e.g. dynamic integration of ATM constraints into the flight monitoring/flight watching tools), their verification and integration with SWIM Infrastructure allowing all AU to execute the most efficient Business Trajectory in line with their performance requirements.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SESAR Solution PJ.07-4
AU Trajectory Execution from FOC perspective</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AUO-0206 "FOC Management of the Reference Business Trajectory"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 101</td><td>4D Trajectory Management in Step 2</td></tr>
<tr><td>SWIM-APS-05b</td><td>Provision and Consumption of Flight Object Sharing services for Step 2</td></tr>
<tr><td>SWIM-SUPT-01b</td><td>SWIM Supporting Registry</td></tr>
</table></td><td>Not addressed</td><td></td><td>V1</td><td></td><td>V2</td></tr>
</table>

SWIM-SUPT-06b	SWIM Supporting Supervision					

Identification of CNS related needs

- See dependencies section.

Identification of MET and AIM related needs

- MET information needs
  - MET information for AU flight Operations and for all stakeholders involved in UDPP including information to support: de-icing process and all other operational aspects that require planning from 3 days to 2 hours before departure
  - Further MET information requirements need to be detailed based on operational integration requirements established
- AIM information needs
  - AIM information requirements need to be detailed based on operational integration requirements established

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- The Solution requires SWIM services (to be further developed)

Performance Goals

The main performance objectives include:

- Increased Flexibility by allowing the Airspace Users to recommend to the Network Management function a priority order for flights. This KPA is driving the reduction of direct and possibly indirect costs to AUs
- Increased Efficiency: this KPA in SESAR includes Fuel Efficiency and only partially reflects the AU driver ‘Flight Efficiency’. NOTE: a current initiative (AU, NM collaboration) is aiming at a shared definition of Flight Efficiency. This new definition shall be incorporated into the performance objectives of the PJ.07 project
- 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

Identification of impacted KPAs & Transversal Areas.

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.07-01 AU Processes for Trajectory Definition		**H**	**M**	**H**				**M/H**	**H**	**H**	**H**	
SOLUTION PJ.07-02 AU Fleet Prioritization and Preferences (UDPP)			**M**	**H**					**H**	**H**		
SOLUTION PJ.07-03 Mission Trajectory Driven Processes			**M**				**H**		**M**	**M**	**H**	
SOLUTION PJ.07-04 AU Trajectory Execution from FOC perspective		**H**	**M**	**H**	**M/H**			**M/H**	**H**	**H**	**H**	

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.07-01 AU Processes for Trajectory Definition	**L/N**	

SOLUTION PJ.07-02 AU Fleet Prioritization and Preferences (UDPP)	**L/N**	
SOLUTION PJ.07-03 Mission Trajectory Driven Processes	**N**	
SOLUTION PJ.07-04 AU Trajectory Execution from FOC perspective	**L/N**	

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.07-01: AU Processes for Trajectory Definition

- SESAR 1 P11.01.02 Step1 FOC FINAL OSED/SPR/INTEROP
- SESAR 1 P11.01.02 Step2/3 FOC FINAL OSED/SPR/INTEROPSESAR 1 P07.06.02 Step1 FINAL OSED
- SESAR 1 P07.06.02 Step2 V1 OSED

Solution PJ.07-02: AU Fleet Prioritization and Preferences (UDPP)

- SESAR 1 P07.06.02 D79 Step 2 V2 UDPP FINAL OSED
- SESAR 1 P07.06.02 D75 Step 2 V2 UDPP VALP
- SESAR 1 P07.06.02 D76 Step 2 V2 UDPP VALR
- SESAR 1 DEMO DFLEX

Solution PJ.07-03: Mission Trajectory Driven Processes

- SESAR 1 P07.06.02 D48 Step 1 Technical Specs for OAT prototype
- SESAR 1 P07.06.02 D51 Step 1 Mission trajectory OSED 2015 update
- SESAR 1 P11.01.02 D10 D11.1.2.3mb-WOC - Final WOC Step 1 and Step 2, as available, OSED/SPR/INTEROP
- SESAR 1 P11.01.03 D18 D11.1.3-4mb-WOC - Updated WOC Step 1 and 2 TAD (BMT, AFUA, iOATFPL)
- SESAR 1 P11.01.03 D16 D11.1.3-2mb-WOC - Update Technical Specification Step 1 & Step 2 as available for WOC system (BMT, AFUA, iOATFPL)

Solution PJ.07-04: AU Trajectory Execution from FOC perspective

- SESAR 1 P11.01.02 Step1 FOC FINAL OSED/SPR/INTEROP
- SESAR 1 P11.01.02 Step2/3 FOC FINAL OSED/SPR/INTEROP
- SESAR 1 P07.06.02 Step1 FINAL OSED
- SESAR 1 P07.06.02 Step2 V1 OSED

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.07			
Source Project	Source Solution	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-03 Mission Trajectory Driven Processes	PJ.07-04 AU Trajectory Execution from FOC perspective
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨		
PJ.04 Total Airport Management	PJ.04-01 Enhanced Collaborative Airport Performance Planning and Monitoring		▨		
	PJ.04-02 Enhanced Collaborative Airport Performance Management	▨	▨		▨
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	▨	▨		▨
PJ.08 Advanced Airspace Manegement	PJ.08-01 Management of Dynamic Airspace configurations	▨	▨		▨
	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3				▨
PJ.09 Advanced DCB	PJ.09-01 Network Prediction and Performance	▨	▨		
	PJ.09-03 Collaborative Network Management Functions	▨	▨	▨	▨
PJ.13 Air Vehicle Systems	PJ.13-02-01 GA/R Specific Communication Systems				▨
PJ.16 CWP - HMI	PJ.16-03 Virtual Centre concept	▨			
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories		▨		▨
	PJ.18-02 Integration of trajectory management processes in planning and execution	▨	▨		▨
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	▨	▨		▨
SESAR1	#28 Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing				▨
	#34 Digital Integrated Briefing	▨			
	#37 Extended Flight Plan	▨		▨	
	#46 Initial SWIM	▨	▨	▨	▨
	#56 ATFM Slot Swapping		▨		
	#57 UDPP Departure		▨		

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

Source Project	Source Solution	PJ.02	PJ.03a	PJ.04	PJ.06	PJ.08	PJ.09	
		PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.03a-01 Enhanced Guidance Assistance to Aircraft on the Airport Surface Combined with Routing	PJ.04-01 Enhanced Collaborative Airport Performance Planning and Monitoring	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	PJ.08-01 Management of Dynamic Airspace configurations	PJ.09-01 Network Prediction and Performance	PJ.09-03 Collaborative Network Management Functions
PJ.07 Optimised Airspace Users Operations	PJ.07-01 AU Processes for Trajectory Definition		▨			▨	▨	
	PJ.07-02 AU Fleet Prioritization and Preferences	▨	▨	▨	▨	▨		
	PJ.07-03 Mission Trajectory Driven Processes							▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,:

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

The project shall ensure global interoperability with non ECAC airlines and ATM actors.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

ATMRPP work on FIXM and in particular flight/fleet prioritisation when appropriate.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (FOC, Military, Network management, Airport),
    - ATM Operational Experience (Flight Ops, Wing Ops, Network management, Airport),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - MET Expertise
    - AIM Expertise
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, FOC/WOC systems, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Optimisation
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance assessment and analysis, business case analysis, modelling
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- OSED
- SPR
- INTEROP
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Effort

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.7 Optimised ATM Network Services – Advanced Airspace Management (PJ08)

PJ.08	**Advanced Airspace Management**

Problem Statement

Today, Air Traffic Flow and Capacity Management (ATFCM), Airspace Management (ASM) and Air Traffic Control (ATC) are separated processes even though the coordination between all in Step 1 has significantly improved through interfacing between ATFCM, ASM and ATC systems.

With Step 1 solutions, full integration between ATFCM, ASM, and ATC processes, as well as full collaboration between ATM Actors and Airspace Users did not take place, not only constrained by the available technology and limited tools, e.g. e-mails, meetings, videoconference, e-conferencing and avionics equipment, but especially by the limitations of the processes based on ATM operational environment, causing a lack of situational awareness and resulting in sub-optimal use of ATM resources.

The current ATM environment and Step 1 solutions do not provide a firm and confident prediction of traffic with which to determine appropriate required Airspace Design, and the efficient application of Flexible Use of Airspace (military and civil coordination). Also, the sharing of airspace information is not optimally adapted to Aircraft Operators (AO) and other Airspace User (AU) processes, which is leading to limited usage of available dynamic configurable airspace. Decisions related to airspace organisation and resource allocation are only made when the emerging traffic demand information is available.

Similarly, the current ATM environment provides neither an accurate prediction of traffic and relevant measurements of its uncertainty, nor the sector predicted workload with a confidence index, with which to determine efficient airspace organisation. The confidence index expresses the level of certainty in % between 0 and 100 that the predicted traffic or workload will correspond with the real traffic or workload.

Without a common situational awareness, simultaneous operations of civil and military users in a Free Route environment with a high complexity level will be problematic.

The aim of the document is to describe the Advanced Airspace management or 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 further V2 and V3 validation exercises (Real Time Simulation (RTS) and possibly live-trial).

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

Dynamic Airspace Configuration (DAC) in the context of Advanced Airspace Management (AAM) is realised by sector design and sector configuration which will be based on traffic flow complexity and historical data. DAC 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, in order to optimise airspace configuration based on "Predicted Workload".

Airspace configuration would be fully integrated in DCB processes for all phases at local, sub-regional and regional levels. That means that the processes for elaborating airspace configuration include DCB assessment, and vice versa. This ensures that, in case of any DCB issues, one of the possible means to solve imbalances is airspace (re)configuration, and it will be initiated by the DCB function.

The project shall address the definition and refinement of relevant interfaces between Advanced Airspace Management and other processes such as DCB, FRA, NOP, flight planning, etc.

In long-term planning, Flexible Airspace is designed to predict the needed resources (ATCOs) to fulfil the forecasted AU demand, according to the uncertainty of this demand and the confidence index calculated on the resulting Airspace organisation. Decisions can be taken to face the forecast demand according to the Airspace organisation confidence index.

Regarding coordinated Military Airspace demand, Dynamic Mobile Areas (DMA) are temporary volumes of airspace designed to separate the activities performed inside from civil traffic. DMAs aim to satisfy user needs whilst minimising impacts on the network. As such a DMA is a type of an Airspace Reservation or ARES.

Dynamic mobile area (DMA) is an integral part of the Mission Trajectory (MT) described by a 4D data set. DMA constitutes a defined volume of airspace that satisfies specific operational requirements from different Airspace Users (AU).

There are three types of DMA that have been identified:

- **DMA Type 1** is a volume of airspace of defined dimensions described as an integral part of a MT at flexible geographical locations agreed upon in a CDM process satisfying Airspace Users requirements in terms of a time and/or distance constraint parameters from a reference point as specified by AU (e.g. Aerodrome of Departure).
- **DMA Type 2** is a volume of airspace of defined dimensions described as an integral part of a MT and agreed upon in a CDM process satisfying the Airspace Users requirements. This volume of airspace can be planned and used at any geographical location along the trajectory.
- **DMA Type 3** is a volume of airspace of defined dimensions described as an integral part of a MT and agreed upon in a CDM process satisfying the Airspace Users requirements. This volume of airspace is designed around moving aircraft (an aircraft-centric bubble) requiring specific separation criteria based on aircraft configuration (e.g. Fighter, Tanker, Formation).

The scope of Project PJ.08 with regards to DMA is to manage the integration of the three types of DMA into the DAC process by taking into account the requests and propose alternative solutions as part of the CDM process.

Project PJ.07 will define the requirements from the Airspace Users for the definition and design of DMAs as part of the Mission Trajectory.

Project PJ.18 shall cover the integration and processing of DMAs as part of the Mission Trajectory (MT) management.

To ensure a consistent definition of the Free Routing Airspace or FRA characteristics together with DMA 1, 2 and 3 implementation and management, PJ 08 will work in close coordination with PJ06.

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. This possibility is even more important in FRA where traffic patterns are more varied and spread out. The objective of Dynamic Sectorisation is not limited to recurrent traffic only but also deals with unpredictable changes in traffic demand (e.g. due to unannounced industrial action, system outages, exceptional weather circumstances that were not predicted).

In case there are some left over services from SESAR I related to Airspace Status, then their development will be included in this project.

ATM Airspace resources (Airspace structures and system support) efficiency management 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.

ATM Network performance will be improved through a seamless integration of Airspace Management functions into the DCB process and enhanced system prediction capability and confidence index. The DAC services used by DCB are Capacity Management services. These will be included in the scope of PJ.08. PJ.09 will deal with how these Capacity Management services are integrated in the DCB process.

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 in a specific area is out of equilibrium, or out of proportion with regard to other directly-related areas, as well as the assessment of impact on airspace capacity, predictability, flexibility, fuel efficiency, and safety (Workload Prediction is not part of this project, but in PJ.09). 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 (NM, FABs, ANSPs), all contributing towards the delivery of a seamless process where the macro-optimum solution will generally be chosen in favour of the micro-optimum with full stakeholder consultation and agreement.

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 ATCO resources is a key issue for ANSPs to optimise cost. Improvements to long term planning will increase confidence in the forecast traffic and the proposed airspace organisation.
- Better use of resources. Smoothing of ATCO resources by Airspace organisation is an efficient means to save ATC resources without touching AU demand. AAM manages resources in an optimum way' driven by constraints on results.
- As result of the above, a positive impact on cost effectiveness is expected even when/if air traffic and ATCO workload may increase.
- Higher ability to propose adequate Airspace organisation without touching AU demand. An automated tool integrated as the first step in the DCB process will support the management and assessment of a higher number of possible solutions to respond to traffic forecast.

- Anticipated Airspace Solution publication. Publication in the NOP of a coordinated Airspace plan between Civil and military through AAM, allows 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 allows rapid Airspace reorganisation based on constraints results (Number of ATCOs etc.).
- 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 Dynamic Airspace Configuration (DAC) solutions at local, sub-regional and regional levels.
- Dynamic Airspace Configurations will be adjusted to Airspace Users' preferences in a Free Route environment without constraints on military activities.
- Will enhance common situational awareness facilitating simultaneous operations of civil and military airspace users in Free Routing airspace with different complexity levels.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

The Operational Improvements or OI and enablers listed in the solutions below, is based on Dataset 13. The list of enablers is likely to evolve and will be completed when available.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.08-01: Management of Dynamic Airspace configurations

Solution Description:

This SESAR solution develops the process, procedures and tools related to Dynamic Airspace Configuration or DAC management, supporting Dynamic Mobile Areas of Type 1 and Type 2, through:

- Subject to benefits being proved in earlier validations, up-linking the status of the airspace structures (activated or deactivated). They are displayed in the aircraft, allowing a shared situational awareness of ASM related information between all ground stakeholders and aircrews.

  Additionally, areas that are not in on-board database are uplinked by the ground and displayed to the aircrew. Preferred trajectories avoiding the uplinked areas are determined. In SESAR 1, all ATM stakeholders including FOC/WOC, ASM functions, ATC Centres were already linked to the real time status of airspace structures. This solution expands the work done in SESAR 1 regarding ASM shared situational awareness to include the aircrews (both civil and military). The solution will consider the work from SESAR 1 for AIRM, SWIM and the Digital NOTAM concept as transport mechanisms for new airspace structures and their activation / deactivation. Situational awareness is supported by tools that allow visualisation and graphical manipulation of DMAs taking into account human factors considerations in order to achieve suitable safety levels.

- The activation of Airspace configurations through an integrated collaborative decision making process, at national, sub-regional and regional levels. Procedures and system support tools shall be defined to enable the management of the airspace configurations as a continuum to meet the users' expectations. Procedures and interoperable system support tools will allow civil and military airspace managers, flow managers to: assess and compare different local/sub-regional airspace configurations (FMPs and FABs level); identify mutual network impact, through a continuous CDM process aiming at providing the best airspace configurations at network level from planning to execution phases; and, make optimum use of the available airspace and human resources to meet the users expectations. The solution will – in support of the CDM process - address tools that allow tracing and automating a flexible CDM process with the help of business process management technology.

- En-route ATC sectors design principles enables a seamless and coordinated approach for airspace configurations from planning to execution phases, increasing the Network capability to continuously adapt to demand pattern changes and traffic flows volatility induced through the extensive implementation of free route operations. More flexibility is allowed in defining a larger number of elementary sectors/airspace blocks and a more extensive application of cross border sectors by means of e.g. complexity forecasts and what-if analysis.

- En-route ATC sectors configurations are aimed to adapt to dynamic TMA boundaries and both fixed and dynamic elements (i.e. fixed and flexible routing, reserved/restricted airspace (ARES, CBA, CBO, DMA)).

The DAC process and tools shall support Dynamic Mobile Areas (DMA) of type 1 and type 2. In a separate SESAR solution, the support of Dynamic Airspace Configuration shall be extended to DMA type 3.

This SESAR Solution PJ.08-01 shall also foresee in the design and development of dynamic airspace configuration tools to support the civil and military preferred trajectories.

These tools will support Dynamic Sectorisation and Constraint Management for the purpose of workload and complexity optimisation at local level. The objective is to manage the airspace as a continuum to meet the users' expectations. Integrating complexity management in the DCB process, this automated support optimises airspace configuration based on workload and complexity, avoiding inconsistencies and side effects in the activation of airspace structures. It encompasses sector organisations based on predefined basic airspace volumes, interfaces between En Route and TMA, activation of free route airspace structures, management of the use of airspace over Cross Border Areas and Dynamic Mobile Areas, Dynamic Airspace Configuration to answer to the User Preferred Routing concept and to solve complexity and DCB issues.

The system provides support for the assessment and comparison of different airspace configurations, for the decision making process, taking into account different kind of parameters, and for the monitoring of the implemented solutions in order to make best use of the available airspace and human resources at any given time.

Operating Environment: Regional, sub-regional, local levels.

All airspace users including RPAS, GA, rotorcraft as well as military will benefit from a more optimised airspace configuration. This solution suits directly the military needs for mission trajectory and at the same time minimises the impact of the airspace reserved for particular mission type.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.08-01: Management of Dynamic Airspace configurations</th><th colspan="5">Maturity</th></tr>
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<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>AOM-0208-B "Dynamic Mobile Areas (DMA) of types 1 and 2"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-61</td><td>Handling of additional military datalink messages in military aircraft for ATM purpose.</td></tr>
<tr><td>A/C-62</td><td>Onboard management of dynamic mobile area</td></tr>
<tr><td>AAMS-16a</td><td>Airspace management functions equipped with tools able to deal with free-routing</td></tr>
<tr><td>AIMS-15</td><td>Aeronautical Information sub-system enhanced to be able to handle Dynamic Mobile Areas</td></tr>
<tr><td>CTE-C02b</td><td>A/G Datalink over ATN/OSI - Single frequency</td></tr>
<tr><td>CTE-C02c</td><td>A/G Datalink over ATN/OSI - Multi frequency</td></tr>
</table></td><td>V2</td><td></td><td></td><td></td><td>V3</td></tr>
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<tr><td>CTE-C02e</td><td>New A/G datalink using ATN/IPS over L-band</td></tr>
<tr><td>CTE-C02f</td><td>Future Satcom for ATM- P15.2.5 Precursor for SBB</td></tr>
<tr><td>CTE-C06b</td><td>PENS - Phase 2</td></tr>
<tr><td>ER APP ATC 80</td><td>Enable ATC System to Use Dynamically-Defined Airspace Reservations</td></tr>
<tr><td>NIMS-14a</td><td>Demand Data Repository Phase I</td></tr>
<tr><td>NIMS-14b</td><td>Demand Data Repository Phase II</td></tr>
<tr><td>NIMS-14c</td><td>Demand Data Repository Phase III</td></tr>
<tr><td>NIMS-19</td><td>Flight Planning management sub-system enhanced for AFUA</td></tr>
<tr><td>PRO-146</td><td>ASM Procedures for agreeing and promulgating information on Mobile Exclusion Areas</td></tr>
<tr><td>PRO-147</td><td>Military Procedures for assessing requirements and developing Mobile Exclusion Areas</td></tr>
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<td></td><td></td><td></td><td></td><td></td>
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<td>
AOM-0805 "Collaborative Airspace Configuration"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-12</td><td>Airspace management system equipped with a method to achieve regional airspace coordination capability</td></tr>
<tr><td>AAMS-13</td><td>ASM scenario management sub-system equipped with tools for assessing the impact of airspace changes on capacity</td></tr>
<tr><td>AIMS-04</td><td>Network management functions supported with real-time airspace data</td></tr>
<tr><td>ER APP ATC 15</td><td>Flight Data Processing: support Dynamic Sectorisation and Dynamic Constraint Management.</td></tr>
<tr><td>ER APP ATC 80</td><td>Enable ATC System to Use Dynamically-Defined Airspace Reservations</td></tr>
<tr><td>NIMS-04</td><td>ATFCM capacity planning sub-system enhanced to take into account dynamic sector shapes</td></tr>
<tr><td>NIMS-30</td><td>ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency</td></tr>
<tr><td>PRO-010</td><td>Military Procedures to ensure that all operations that are involved with the airspace reservation are cognizant of the changes in cooperation with ASM</td></tr>
<tr><td>PRO-011</td><td>ASM Procedures to ensure that the change in airspace availability is promulgated through SWIM and reflected in the NOP</td></tr>
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<td>V2</td><td></td><td></td><td></td><td>V3</td>
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AOM-0809 "Sector Design and Configurations Unconstrained by Predetermined Boundaries"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-12</td><td>Airspace management system equipped with a method to achieve regional airspace coordination capability</td></tr>
<tr><td>AAMS-13</td><td>ASM scenario management sub-system equipped with tools for assessing the impact of airspace changes on capacity</td></tr>
<tr><td>AIMS-22</td><td>Airspace management functions enhanced to provide airspace status information</td></tr>
<tr><td>ER APP ATC 15</td><td>Flight Data Processing: support Dynamic Sectorisation and Dynamic Constraint Management.</td></tr>
<tr><td>ER APP ATC 80</td><td>Enable ATC System to Use Dynamically-Defined Airspace Reservations</td></tr>
<tr><td>NIMS-04</td><td>ATFCM capacity planning sub-system enhanced to take into account dynamic sector shapes</td></tr>
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</table>

</td><td>V2</td><td></td><td></td><td></td><td>V3</td></tr>
<tr><td>

CM-0102-B "Automated Support for Dynamic Airspace Configuration"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIMS-23</td><td>Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements</td></tr>
<tr><td>CTE-C05b</td><td>Digital Voice / VoIP for ground segment of Air-Ground voice</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-05b</td><td>Provision and Consumption of Flight Object Sharing services for Step 2</td></tr>
</table>

</td><td>V2</td><td></td><td></td><td></td><td>V3</td></tr>
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<tr><td>SWIM-SUPT-01b</td><td>SWIM Supporting Registry</td></tr>
<tr><td>SWIM-SUPT-03b</td><td>SWIM Supporting Security</td></tr>
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<tr>
<td>
AOM-0206-B "Sharing real time airspace information with the aircraft"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-03</td><td>Determination of a preferred trajectory avoiding an area not existing in onboard data base</td></tr>
<tr><td>A/C-40</td><td>Uplink of an area dynamically activated and not existing in onboard data base</td></tr>
</table>
</td>
<td>V1 on-going</td><td></td><td>V1</td><td>V2</td><td>V3</td>
</tr>
</table>

<u>Identification of CNS related needs</u>

- Air-Ground data link will need updates to exchange the real time status of an airspace with the aircraft as well as DMA Type 1 and Type 2 information.
- PJ14 will provide this solution as part of PJ14.02.01 and PJ14.02.02 related to Future communication Infrastructure (FCO).

<u>Identification of MET/AIM related needs</u>

- ATC Sector Design will take MET factors into account.
- AIM model will be updated to support DMA type 1 and 2.

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Sharing of airspace status and DMAs type 1 and type 2 via SWIM
- Planning and tactical information exchange via SWIM is used to manage any irregular traffic flows of commercial, military and/or GA traffic to regional airfields
- Access via SWIM service to MET data for DMA position determination, link to PJ.17

SESAR Solution PJ.08-02: Dynamic Airspace Configuration supporting moving areas

<u>Solution Description:</u>

This SESAR Solution will extend the management of Dynamic Airspace configuration to support moving areas. This includes Dynamic Mobile Areas or DMA of type 3 as well as moving hazard areas.

DMA Type 3 is a volume of airspace of defined dimensions described as an integral part of a MT and agreed upon in a CDM process satisfying the Airspace Users requirements. This volume of airspace is designed around moving aircraft (an aircraft centric bubble) requiring specific separation criteria based on aircraft configuration (e.g. Fighter, Tanker, Formation).

This solution will be a continuation of Solution PJ.08-01 to extend the support of DAC to DMA type 3. It will include all updates needed to DAC management and processes as required as well as the update of all involved systems and tools to support DMA type 3.

This solution will also include the automated impact assessment of hazard areas due to weather phenomena that can evolve in 4 dimensions and integrate those in the DAC process. The possibility exists to extend these hazard areas due to other phenomena such as volcanic ash.

Operating Environment: Network and en-route, Sub Regional and local.

This solution suits directly the military needs for mission trajectory and at the same time minimises the impact of the airspace reserved for particular mission types.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.08-02: Dynamic Mobile Areas (DMA) of type 3</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
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<tr><td>AOM-0208-C "Dynamic Mobile Areas (DMA) of type 3"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>CTE-C02b</td><td>A/G Datalink over ATN/OSI - Single frequency</td></tr>
<tr><td>CTE-C02e</td><td>New A/G datalink using ATN/IPS over L-band</td></tr>
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</table></td><td>Not addressed</td><td></td><td></td><td></td><td>V1-V2-V3</td></tr>
<tr><td>AOM-0209 " Integrate Hazard Zones in DAC process"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-01</td><td>Automated impact of Hazard Zones</td></tr>
</table></td><td>Not addressed</td><td></td><td></td><td></td><td>V1-V2-V3</td></tr>
</table>

Identification of CNS related needs

- Air-Ground data link will need updates to exchange DMA Type 3 information.
- PJ14 will provide this solution as part of PJ14.02.01 and PJ14.02.02 related to Future communication Infrastructure (FCO).

Identification of MET/AIM related needs

- ATC Sector Management will take MET factors into account.

- AIM model will be updated to support DMA type 3.
- MET system will be updated to pass hazard area information

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Sharing information regarding the airspace status and DMA type 3 via SWIM, possibly update of SWIM services related to type 1 and type 2.
- SWIM services passing information on hazard area due to weather phenomena.

Performance Goals

The main performance goals for this project include:

- 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 decrease 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 and of Local Tools : 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. Local tools will benefit from the provided SWIM services through easy connectivity to NM and by means of a convenient and economical way to exchange information with the Network.
- Safety: Advanced Airspace Management should ensure that safety standards will not be downgraded enabled by automated support tools and may be improved through an increased common situational awareness at sub-regional and regional levels.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.08-01 **Management of Dynamic Airspace configurations**	**H**	**M**	M	H	**M**	**H**		**M**	**M**	H	M	**H**
SOLUTION PJ.08-02 **Dynamic Mobile Areas (DMA) of type 3**	**M**	**M**	**M**	M	**M**	**H**		**M**	**M**	M	M	**L**

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.08-01 **Management of Dynamic Airspace configurations**	N	AOM-0206-B: Sharing Real time Information with the Aircraft AOM-0805: Collaborative Airspace Management AOM-0208-B Dynamic Mobile Areas of DMA type 1 and 2. Allocation needs negotiated through CDM process. CM-0102-B: Automated Support for Dynamic Airspace Configuration Management. Tools to be used in a CDM process
SOLUTION PJ.08-02 **Dynamic Mobile Areas (DMA) of types 3**	N	AOM-0208-C Dynamic Mobile Areas of DMA type 3. Enablers: datalinks A/G, PENS 2

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.08-01 Management of Dynamic Airspace Configuration

- SESAR 1 P07.05.04 D54 OSED Step2-V2 v 3.0
- SESAR 1 P07.05.04 D56 SPR Step2-V2 v1.0 delivery
- SESAR 1 P07.05.04 D82 Technical specification Step 2-V2 v2.0 delivery
- SESAR 2020 High-level OSED PJ.06
- SESAR 1 WPB 04.02 Step 2 CONOPS
- SESAR 1 P04.02 Step 2 DOD
- SESAR 1 P07.02 DOD

Solution PJ.08-02: Dynamic Mobile Areas (DMA) of types 3

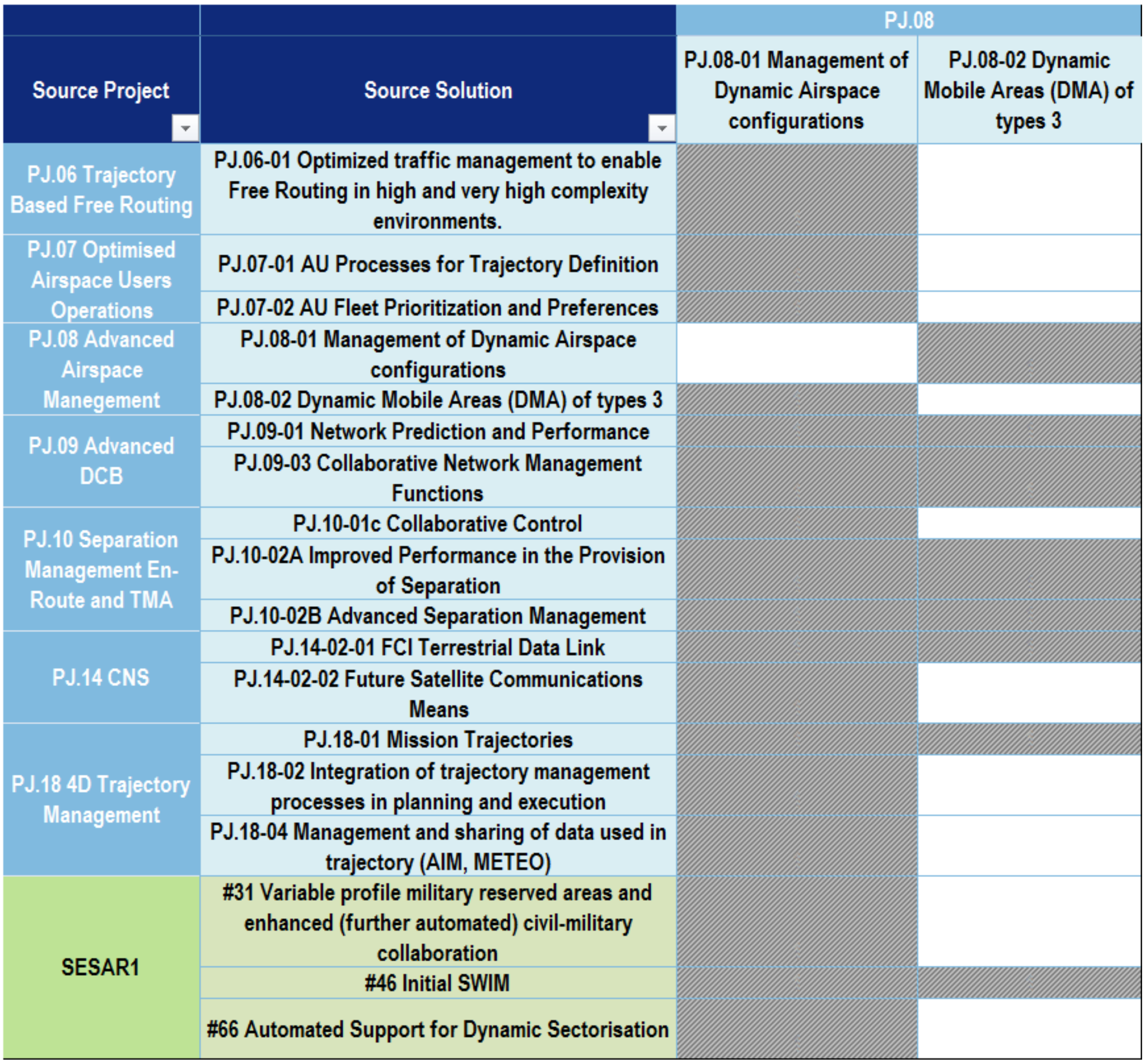
- SESAR 2020 deliverables from PJ.08-01

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.



		PJ.08	
Source Project	Source Solution	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	▨	
PJ.07 Optimised Airspace Users Operations	PJ.07-01 AU Processes for Trajectory Definition	▨	
	PJ.07-02 AU Fleet Prioritization and Preferences	▨	
PJ.08 Advanced Airspace Manegement	PJ.08-01 Management of Dynamic Airspace configurations		▨
	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	▨	
PJ.09 Advanced DCB	PJ.09-01 Network Prediction and Performance	▨	▨
	PJ.09-03 Collaborative Network Management Functions	▨	▨
PJ.10 Separation Management En-Route and TMA	PJ.10-01c Collaborative Control	▨	
	PJ.10-02A Improved Performance in the Provision of Separation	▨	▨
	PJ.10-02B Advanced Separation Management	▨	▨
PJ.14 CNS	PJ.14-02-01 FCI Terrestrial Data Link	▨	▨
	PJ.14-02-02 Future Satellite Communications Means	▨	
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories	▨	▨
	PJ.18-02 Integration of trajectory management processes in planning and execution	▨	
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	▨	
SESAR1	#31 Variable profile military reserved areas and enhanced (further automated) civil-military collaboration	▨	
	#46 Initial SWIM	▨	▨
	#66 Automated Support for Dynamic Sectorisation	▨	

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.07			PJ.08		PJ.09
Source Project	Source Solution	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	PJ.09-02 Integrated Local DCB Processes
PJ.08 Advanced Airspace Manegement	PJ.08-01 Management of Dynamic Airspace configurations	▨	▨	▨		▨	▨
	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3			▨	▨		▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

None at the present time

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management),
    - ATM Operational Experience (En Route, TMA, Network management),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Mission Trajectory detailed concept,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics (including military ones) ;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
    - Operational Research and Optimisation Techniques
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.8 Optimised ATM Network Services – Advanced Demand & Capacity Balancing (PJ09)

PJ.09	**Advanced DCB**

Problem Statement

SESAR 1 developments in the context of network operations have demonstrated improvements in the reliability of planning data which will enable the reduction of ATM capacity held in reserve for exceptional demand capacity imbalance situations. Short Term ATFCM Measures (STAM) will further improve the flexibility of the Network Management function to tactically manage imbalances and complexity issues in the Network. This has shown a reduction in the application of ‘broad brush’ constraints and regulations. Further emphasis is needed to improve the organisation of resources across ACCs (Area Control Centre), the scoping of measures from local ACC’s to full network impact assessment, and to promote opportunity measures over those with implication on airspace users costs (e.g. delay/airline schedule disruption, fuel/extra miles, extra charges etc.).

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 (Demand Capacity Balancing) 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 and not systematically integrated in the NOP. Information regarding Military operations is subject to operational constraints, and the ATM and military networks are not as fully integrated as they could be even considering military secrecy. The operational data does not yet reflect a unique set of real time data to support tactical DCB processes, collaborative decision making and network performance monitoring in the execution phase. In conclusion, the appropriate level of “Network Intelligence”, where all information is accessible to everyone and all of that information is distributed in a transparent but cohesive way is not yet achieved.

System capacity is impacted by insufficient flexibility in the short term DCB phase and the lack of ATC involvement in the DCB process execution. DCB measures are not fully compatible to support Free Route operations in high complexity environment. This rigidity is aggravated by the absence of a single seamless DCB management process that involves airspace users, 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 predicted impact on network performance.

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 needs to be done to improve/expand the dynamic integration of operational data, to enable tailored real time network performance assessment, to facilitate collaborative DCB processes and to manage adherence to it.

Further development of automated tools, for optimisation and monitoring of 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.

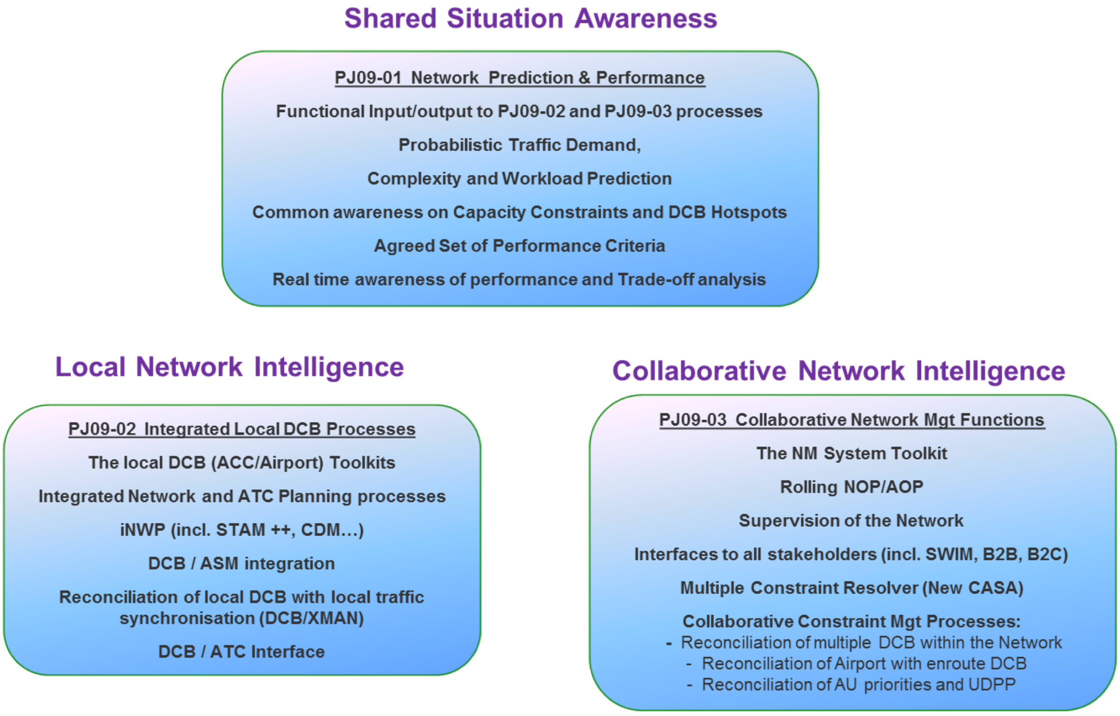
This will permit a proactive identification of constrained points in the Network and the application of collaborative procedures to address the situation with the least number of trajectory changes as possible.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

PJ.09 Advanced DCB consists of three SESAR Solutions:

- PJ.09-01 Network Prediction and Performance
- PJ.09-02 Integrated Local DCB Processes
- PJ.09-03 Collaborative Network Management Functions



Shared Situation Awareness

PJ09-01 Network Prediction & Performance

Functional Input/output to PJ09-02 and PJ09-03 processes

Probabilistic Traffic Demand,

Complexity and Workload Prediction

Common awareness on Capacity Constraints and DCB Hotspots

Agreed Set of Performance Criteria

Real time awareness of performance and Trade-off analysis

Local Network Intelligence

PJ09-02 Integrated Local DCB Processes

The local DCB (ACC/Airport) Toolkits

Integrated Network and ATC Planning processes

iNWP (incl. STAM ++, CDM…)

DCB / ASM integration

Reconciliation of local DCB with local traffic synchronisation (DCB/XMAN)

DCB / ATC Interface

Collaborative Network Intelligence

PJ09-03 Collaborative Network Mgt Functions

The NM System Toolkit

Rolling NOP/AOP

Supervision of the Network

Interfaces to all stakeholders (incl. SWIM, B2B, B2C)

Multiple Constraint Resolver (New CASA)

Collaborative Constraint Mgt Processes:
- Reconciliation of multiple DCB within the Network
  - Reconciliation of Airport with enroute DCB
  - Reconciliation of AU priorities and UDPP

These three SESAR Solutions are the main building blocks to complement the Network Management with a sort of Network Intelligence based on shared situation awareness, a common set of values and rules and highly interconnected local network management functions operating performance driven as a compound based on the principal “think regional, act local”.

“Collaborative Network Management Functions” (Solution PJ.09-03) delivers subsidiary Network Management based on transparency, performance targets and agreed control mechanisms.

Near real time data and visualisation of AOP/NOP evolving planning environment (such as weather, demand pattern and capacity bottlenecks) is available to support AU and local planning activity. Network Operations planning and execution is managed by an agreed set of rules and procedures (including what-if), guiding subsidiary DCB and UDPP (User Driven Prioritisation Process) measures under consideration of trade-offs and network performance targets.

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.

Tailored weather information fulfilling now cast and forecast shall be provided by enhanced MET observations (PJ.17). Where available, the airport constraints shall be derived from the AOP and the collaborative management processes defined in the APOC implementation.

"Integrated Local DCB processes" (Solution PJ.09-02) will deliver benefits in 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 improved by developing the Network Operations Plan (NOP) towards a robust optimum with sufficiently regular updates and managed stability (in both the long, and medium to short term phases), using the latest known traffic and complexity/workload information. Airport and ATC resource efficiency will be further enhanced through the availability of improved traffic predictability, as an enabler which will allow a better planning and management of the resources. 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 preferred optimal 4D flight profiles. The precise adjustment of the NOP should lead to the balance between Demand and Capacity to the highest level of network performance, thus increasing the decision-making capability of the concerned actors.

Forward looking proactive involvement 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 (Solution PJ.09-01). This information will be used as an enabler 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) in fixed and free route environment 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 in subsidiary collaboration 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 and Wings Operations Centre (FOC/WOC) and the Flight deck (if capable to do it) should play an active role in the execution and facilitation of the Network operations plan and the implemented initiatives. In particular, the FOC will be given the opportunity to consider constraints provided in 4D format and to generate preferred trajectories that will be used through the DCB processes. The NOP will be the main source of the input parameters 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 through the NOP where the outcome of a tactical solution differs from one that was expected.

This DoW assumes that DCB-0308 “advanced Short Term ATFCM”, DCB-0103-A “Collaborative NOP for Step 1”, CM-0103-A “Automated Support for Traffic Complexity Assessment” and CM-0104-A “Automated Controller Support for trajectory management” will be completed during Release 5 in SESAR 1. DCB-0208 “DCB in a trajectory management context” will achieve End of V3 in Release 5 except the feature related to the consolidation of Target Times with AMAN/XMAN and A-CDM that will be addressed under this project as part of SESAR 2020 activities.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.09-01: Network Prediction and Performance

Solution Definition:

Regional, sub-regional and local DCB processes benefit from shared situation awareness with respect to demand, capacity and performance impacts. Traffic and demand forecast have improved reliability based on SBT and the computation of confidence indexes. The diagnosis and awareness of hotspots is more accurate and credible due to enhanced processing based on complexity and workload assessment. Network Operations will be continuously monitored through Network Performance KPA/KPI. Network impact assessment will analyse trade-offs and facilitate collaborative decision making processes.

Solution Description:

The aim of this SESAR Solution is to establish a performance driven network management culture. It complements the current network management process focussed on delay reduction by a shared situational awareness and an agreed set of performance indicators to be used for real time performance monitoring, trade-off analysis and what-if impact assessments.

Network Complexity Prediction 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 be used to enable 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.

The prediction of traffic complexity and the related ATCO workload is key to improving efficiency of DCB processes at regional, sub-regional and local levels. The results of SESAR Solution PJ.09-01 will be used as an input to improve SESAR Solution PJ.09-02 “Integrated Local DCB Processes” and SESAR Solution PJ.09-03 “Collaborative Network Management Functions”.

The implementation of "Network Prediction and Performance" will deliver enhancements to the development of collaborative, performance driven Network Management such as:

- Improved interoperability between AUs and Network operations allowing the exchange of flight profile data among all stakeholders. This includes planned and restricted (reconfigured) flight profiles.
- Improved predictability and situation awareness through the use of MET phenomena now cast and forecast in DCB & dynamic DCB processes, and a probabilistic estimation of network impact regarding different forecast scenarios
- Improved traffic predictability thanks to the elaboration of the probabilistic demand, the consideration of planned ATFCM measures (MDI, MIT etc.) and the consideration and processing of airspace users shared flight information (including a set of confidence indexes and their interpretation) in support of the traffic demand enrichment.
- Improved estimated times of sector entry used for prediction of demand and sector Capacities: through increased awareness and reliability of traffic and workload predictions.
- Identification of complexity hotspots and problematic (complexity/workload intensive) flights and traffic flows. The methodology shall be compliant to dynamic sector operations with the option to support flight-centred ATC if required.
- Use of a commonly agreed set of performance indicators to analyse the performance of network operations at local, sub-regional and regional levels. This will provide a common language to all stakeholders (NM, FMP, ATC, Airport Operator, AU) in support of subsidiary DCB and UDPP and other decision making processes.
- Real time awareness of network performance at local, sub-regional and regional levels
- Future prediction of network performance (including capacity supply forecast and DCB constraints), indication of trends and divergence from performance targets in support of DCB and UDPP processes.
- Indication of performance critical situations and opportunities.
- Trade-off analysis to conclude on the best measure under consideration of all stakeholder needs.
- Development of NOP visualizations on Network performance tailored to AU, ANSPs and Airport needs

Operating Environment:

Network, sub-regional and local level.

Access to network prediction and performance will be available to all authorized ATM stakeholders including Airspace Users through the collaborative NOP.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.09-01:
Network Prediction and Performance</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>DCB-0211 "Traffic & Demand Forecast in 4D trajectory Management Context"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>NIMS-23</td><td>Capacity planning and scenario management equipped with tools integrating SB/MT information, to assist ATS in optimising the use of airport and airspace usable capacity</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
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.</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>CM-0103-B "Automated Support for Traffic Complexity Assessment"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>NIMS-22</td><td>Enhanced performance management sub-system</td></tr>
<tr><td>NIMS-30</td><td>ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency</td></tr>
<tr><td>NIMS-36</td><td>Enhanced Complexity assessment tools</td></tr>
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.</td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
<tr><td>DCB-0212 "Network Performance Assessment for Distributed Network Operation"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>NIMS-22</td><td>Enhanced performance management sub-system</td></tr>
<tr><td>NIMS-34</td><td>Civil-Military performance measurement system</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
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.</td><td>N/A</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
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Identification of CNS related needs

- Flight Object Server (FOS), EPP downlink

Identification of MET and AIM related needs

- MET needs:
  - Nominal MET information (upper wind, temperature) and information on capacity disturbing weather phenomena all through the 4D weather cubes
  - Detailed MET information requirements will be established during project execution
- AIM needs:
  - Airspace status information
  - Detailed AIM information requirements will be established during project execution.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- SWIM services related to SB/MT and RB/MT Dissemination

SESAR Solution PJ.09-02: Integrated Local DCB Processes

Solution Definition:

This solution forms the core functionality for the INAP process (everything which can and should be decided locally - this is the logical follow up of the SESAR1 Local DCB tool set). It includes: INAP management, ASM integrated into DCB (including Dynamic Airspace Configurations), reconciliation of DCB measures with local complexity management, ATC and Arrival Management. The solution addresses the integration of Local Network Management with extended ATC planning and arrival management activities in short term to execution in a seamless process.

Solution Description:

Integrated Local DCB Processes will deliver the expected benefits: Improving the ATM resource management efficiency and improving the effectiveness of complexity resolutions by closing the gap between local network management and extended ATC planning.

ATM resource (including airspace and ground resources) management efficiency will be improved through a seamless integration of Airspace Management functions and Dynamic Airspace Configurations (DAC) (developed by PJ08: Advanced Airspace Management) into the advanced DCB process.

Local DCB actors operate within an INAP (Integrated Network ATC Planning) working environment providing access to all DCB capacity and traffic management options. The local roles (Local Traffic Management, Extended ATC Planning, Flow Management, APOC) will be able to identify and manage the best performing option between ASM capacity measures and traffic management measures to solve local hotspots and complexity problems.

This will include the definition and refinement of associated processes, roles, responsibilities and information exchanges between local DCB and extended ATC planning and support activities.

The implementation of "Integrated Local DCB Processes" will provide the following improvements to the advanced DCB process:

- Improved cost-effectiveness through more effective resource planning and better capacity exploitation enabled by integrated Airspace Management with DCB;

- Support of ATFCM measures dedicated to Free Route operations.
- New operational tools should be designed for iNWP (Integrated Network Working Position): dash-board, what-if, messaging, to support CDM, the synchronisation process as well as the interactivities between local actors, AUs and NM activities. This includes a potential amendment of the existing SWIM DCB Federation Service.
- Implementation of an Integrated Network ATC Process (INAP) and appropriate data link to connect ATC (with the STAM measure implementation process to coordinate local operations such as Flight level capping, MIT, MDI and re-routing).
- Rules, procedures and system requirements for the operational reconciliation of local DCB measures (TT, MIT, etc.) with traffic synchronisation activities (AMAN, XMAN)
- Implementation of an Integrated Network ATC Process (INAP) and appropriate data link to provide local ATC with relevant data required to support the Target Time management process in the execution phase. The functionality shall compromise amongst others: TT flight flag; TT cancelation message; airborne TT, TT revision message;
- Reconciliation of Short-Term ATFCM Measures (STAM) used to solve hotspots and complexity issues with strategic conflict management under the responsibility of the ATC planning function (e.g. TRACT).

Operating Environment:

Local ACC. However, subsets of this SESAR solution can be tailored for installation at Sub-regional level or to support APOC operations.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.09-02:
Integrated Local DCB Processes</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>DCB-0213 "Consolidation and facilitation of Target Times between local DCB, Airport CDM and Extended Arrival Management"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>NIMS-46</td><td>Integrated local DCB working position</td></tr>
<tr><td>NIMS-48</td><td>Integrated Network Working Position (iNWP)</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
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DCB-0210: "Full Integration of Dynamic Airspace Configurations into DCB"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-02</td><td>Dynamic Airspace Configuration tools for the Integrated Network Working Position</td></tr>
<tr><td>NIMS-23</td><td>Capacity planning and scenario management equipped with tools integrating SB/MT information, to assist ATS in optimising the use of airport and airspace usable capacity</td></tr>
<tr><td>NIMS-30</td><td>ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency</td></tr>
<tr><td>NIMS-46</td><td>Integrated local DCB working position</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
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CM-0104-B: "Automated Controller Support for Trajectory Management in Dynamic Airspace Management environment"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>NIMS-46</td><td>Integrated local DCB working position</td></tr>
<tr><td>SWIM-APS-03b</td><td>Provision of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-APS-04b</td><td>Consumption of ATFCM Information Services for Step 2</td></tr>
<tr><td>SWIM-INFR-05b</td><td>General SWIM Services infrastructure Support and Connectivity</td></tr>
<tr><td>SWIM-SUPT-01b</td><td>SWIM Supporting Registry</td></tr>
<tr><td>SWIM-SUPT-03b</td><td>SWIM Supporting Security</td></tr>
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CM-0302 "Ground based Automated Support for Managing Traffic Complexity Across Several Sectors"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 17</td><td>Enhance Traffic and Flow Management sub-systems to</td></tr>
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	support dynamic flow management in co-ordination with local, regional, and European levels.
NIMS-09	Capacity planning and scenario management equipped with tool to assess the impact of requested flight level changes
SWIM-APS-03b	Provision of ATFCM Information Services for Step 2
SWIM-APS-04b	Consumption of ATFCM Information Services for Step 2

Identification of CNS related needs

- Interface to local FDPS data and Flight Object Server (FOS), other CNS Meta data via AOP/NOP

Identification of MET/AIM related needs

- MET needs:
  - Nominal MET information (upper wind, temperature) and information on weather phenomena that impact the gate-to-gate trajectory planning and execution; all through the 4D weather cubes
  - Detailed MET information requirements will be established during project execution
- AIM needs:
  - Airspace status information
  - Detailed AIM information requirements will be established during project execution.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- SVA-009 DCB Federation Service

SESAR Solution PJ.09-03: Collaborative Network Management Functions

Solution Definition:

This SESAR Solution delivers subsidiary Network Management based on transparency, performance targets and agreed control mechanism. Real time visualisation of AOP/NOP evolving planning environment (such as weather, demand pattern and capacity bottlenecks) is available to support AU and local planning activity. Network Operations planning and execution is managed by an agreed set of rules and procedures (including what-if), guiding subsidiary DCB and UDPP measures under consideration of trade-offs and network performance targets. Collaborative 4D constraints management integrates AUs priorities and preferences (and associated FOC/WOC processes and systems), reconciliation of DCB measures with Airports, ACCs, AU and NM, relying on the Multiple Constraints Resolver process.

Solution Description:

Network Management 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 based on agreed principals of subsidiarity.

Collaborative 4D Constraint Management will deliver consolidation of subsidiary DCB measures and other conflicting traffic measures with the aim to minimise the adverse impact on airspace user operations and the overall network performance. It is important to distinguish ATM planning constraints resulting in DCB and other traffic measures from the ATC based constraints imposed directly on the trajectory in the execution phase for safety and sequencing purposes(e.g. CTOs/CTAs) Further harmonisation of these 2 levels of constraints should be treated as a part of the INAP.

This SESAR Solution aims at moving from the current slot allocation (based on first planned/first served principle) to a coordinated 4D constraints management process which arbitrates between the owners of the constraint, the actors involved in the solution and the overall network performance needs.

Reconciliation of DCB measures will be performed in collaborative mode with Airports, ACCs, AUs (incl. UDPP) and NM. In case of multiple conflicting constraints, the "Multiple Constraints Resolver" will provide decision support to identify the optimum solution to solve all conflicts.

The Network Manager implements 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, MET information 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 (interdependency with PJ04 and PJ18).

Collaborative Network Operations Planning links all participating organisations to a unique set of network planning data enabling individual player to play an active role in the network management based on the subsidiary principle "think regional, act local". In nominal situations, macro-optimum solution should be chosen in favour of the micro-optimum. However, there are micro- optimisations that the macro world does not need to know about because the impact remains local or between two coordinating actors only. An agreed set of rules will guide Network Management Functions at all levels to escalate only those issues which need to be escalated at higher level.

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, NMF, ATC, Airport, Flight and Wing Operations Centre (FOC/WOC) and the Flight deck (if capable to do so) should play an active role in the execution and facilitation of the Network operations plan and the implemented initiatives. In particular, the FOC will be given the opportunity to consider constraints provided in 4D format and to 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 through the NOP where the outcome of a tactical solution differs from one that was expected.

SBT planning and trajectory management will rely on dynamically updated 4D constraints providing a common baseline for AUs and ATM Network operations to reach agreement on the SBT and the required SBT tolerances.

Coordination and consolidation of Target Times (TTA/TTO) and 4D Tolerance Window, integrated and coordinated within SBT and RBT mechanisms, serves as an enabler to manage the stability of the network. This assumes considerable network integration of local DCB processes in terms of A-CDM and Total Airport Management (TAM) interfaces to consolidate local target time requests with the network (SESAR Solution PJ09-02).

4D Trajectory adjustment to adapt the demand to the available capacity will be defined through a seamless and coordinated approach. Activities will be carried out in subsidiary collaboration at

Regional, Sub-regional, and Local levels. The process engages AUs, airports, ATC and NMF to gather priorities and preferences, to synchronise airports and ACC measures towards the best solution with respect to all stakeholders and the overall network performance needs.

The efficiency of the implemented initiatives will be monitored and compared with the targets assigned as part of the ATM Performance framework. Appropriate revision processes for trajectory measures will be developed in collaboration with PJ18 to ensure appropriate flexibility and adaptability to unforeseen changes in the network.

This solution has a key dependency with Network Prediction and Performance (SESAR Solution PJ09-01) and SWIM information systems, e.g. necessary update rates for MET products.

The implementation of "Collaborative Network Management Functions" will deliver the management framework, the enhanced network management system and other crucial components required to establish distributed collaborative network management based on subsidiarity principals:

- 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);
- The enhanced NM system functionality for the consolidation of multiple conflicting constraints. Evolution of the existing CASA slot algorithms towards a “Multiple Constraint Resolver” in the first Wave with the option to evolve towards using a target function for all stakeholders according to agreed KPIs (in accordance with SESAR Solution PJ09-01: Network Prediction and Performance)
- The implementation of what-if functionality with network impact assessment in support of decision making processes in the context of UDPP, A-CDM and other APOC processes.
- Establishment of an agreed set of rules and procedures (including what-if), guiding subsidiary DCB and UDPP measures under consideration of trade-offs and network performance targets.
- Improved interoperability between AUs (incl. UDPP) and Network Management allows the AU to express preferences and priorities to facilitate the DCB decision making process.
- Common awareness and improved accuracy and reliability of shared data i.e. capacity planning and configurations (AOP/NOP, En-route and Airport DCB).
- Reconciliation of DCB measures with Airport (Airport CDM, Departure Management).
- Consolidated Short-Term ATFCM Measures (STAM) for ground AND airborne flights in support of the dynamic coordination between more than one ACC, AUs, and the Network Manager. Increase response time by use of scenarios that match known challenging (in terms of complexity and workload) traffic pattern with appropriate measures and solution patterns based mainly on predefined scenarios.
- Target Times Over (TTO) with adequate tolerance levels are consolidated with AUs for constrained

flights, in order to improve the predictability of sector loads and to ensure optimum utilisation of available en-route capacity.

- Target Times of Arrivals (TTAs) with adequate tolerance levels are consolidated with AUs for constrained flights, in order to ensure optimum utilisation of available arrival capacity and to reduce arrival delay and the need for holding. TTAs are 'owned' by arrival airports, and coordination between airports and network will be necessary. There is a need to balance adherence needs and flexibility, and therefore the level of adherence to TTA that is beneficial will be the object of validation.

Operating Environment:

Network, Sub-regional and local level. Access to the collaborative NOP will be available to all authorized ATM stakeholders including airspace users.

List of OI steps and enablers:

SESAR Solution PJ.09-03: Collaborative Network Management Functions	Maturity				
	SESAR 1	SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
DCB-0103-B: "Collaborative NOP"	V1	V2			V3

Enabler Code	Enabler Title
METEO-06c	Generate and provide Meteorological information relevant for Network related operations, Step 2
NIMS-12	Demand Capacity Balancing equipped with a tool to identify and arbitrate multiple imbalance and hotspots
NIMS-22	Enhanced performance management sub-system
NIMS-25	Integration of Airport CDM data into Network DCB sub-system
NIMS-30	ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency
PRO-095	Airline Operational Procedures for modifying RBT including agreed TTA to accommodate selected priorities
PRO-098	FCM Procedures for optimising network usage and identifying opportunities for traffic smoothing
PRO-100	FCM procedures to allocate, monitor and update 4D targets for ATFCM purposes
SWIM-APS-03b	Provision of ATFCM Information Services for Step 2
SWIM-APS-04b	Consumption of ATFCM Information Services for Step 2

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<tr><td><table><tr><td>SWIM-APS-07b</td><td>Consumption of Meteorological Information services for Step 2</td></tr></table></td><td></td><td></td><td></td><td></td><td></td></tr>
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Identification of CNS related needs

- EPP downlink
- CPDLC in support of TT management
- CPR,
- Flight Object Server (FOS)

Identification of MET and AIM related needs

- MET needs:
  - Nominal MET information (upper wind, temperature) and information on weather phenomena that impact the gate-to-gate trajectory planning and execution; all through the 4D weather cubes
  - Detailed MET information requirements will be established during project execution
- AIM needs:
  - Airspace status information
  - Detailed AIM information requirements will be established during project execution.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- SVA-xxx SWIM Service relevant to NOP services
- SVA-009 DCB Federation Service

Performance Goals

The main performance goals for this project include:

- Increased efficiency enabling optimised flight trajectories and profiles with the end result being reduced fuel burn, noise and CO2 emissions
- 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.
- 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.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.09-01 **Network Prediction and Performance**	H	H	H	H	M	M		M	M	M		M
SOLUTION PJ.09-02 **Integrated Local DCB Processes**	H	M	M		M	M		M				M
SOLUTION PJ.09-03 **Collaborative Network Management Functions**	M	H	H	H	M	M	M	M	H			H

Need for coordination at European/Global level

LOCAL: *The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;*

NETWORK: *The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).*

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.09-01 **Network Prediction and Performance**	**N**	Traffic and complexity prediction will be performed at local and network level. Traffic Complexities and workload analysis leading to the identification of hotspots will be shared at network level. Network Performance Assessment will be performed at local and network level. Depending on the scope of the KPI/KPA, performance assessment may stay local or be shared at network level in support of collaborative processes.
SOLUTION PJ.09-02 **Integrated Local DCB Processes**	**N**	Although many of the Local DCB processes focus on the local scope, a strong link and interdependency with the network is key to information sharing, measure consolidation and collaborative decision making.
SOLUTION PJ.09-03 **Collaborative Network Management Functions**	**N**	All Collaborative Network management functions are subject to European/Global synchronisation. Collaborative 4D constraints management processes are highly network interactive.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.09-01: Network Prediction and Performance
- SESAR 1 P13.02.03-D423 SPR S2 Final Update
- SESAR 1 P13.02.03-D453 Technical Specification S2 V2 R5 (final)
- SESAR 1 P13.02.03-D403 OSED S2 Final Update
- SESAR 1 P13.02.03-D423 SPR S2 Final Update
- SESAR 1 P13.02.03-D452 Technical Specification S2 V2 R5 (initial)
- SESAR 1 P13.02.03-D451 Technical Specification S2 V2 R4 (final): Multiple Constraint Resolver and GNWP
- SESAR 1 P07.06.01-D45- Final Step 1 OSED
- SESAR 1 P04.07.01-D39- STEP 2 Final OSED
- SESAR 1 P04.07.01-D41- STEP 2 Final Safety and Performance Requirements (SPR)
- SESAR 1 P04.07.01-D42- STEP 2 Final Interoperability Requirements (INTEROP)
- SESAR 1 P10.08.01-D18 Step 2 final Technical Specification

Solution PJ.09-02: Integrated Local DCB Processes
- SESAR 1 P13.02.03-D303 OSED S1 Final Update
- SESAR 1 P13.02.03-D323 SPR S1 Final Update
- SESAR 1 P13.02.03-D403 OSED S2 Final Update

- SESAR 1 P13.02.03-D423 SPR S2 Final Update
- SESAR 1 P13.02.03-D453 Technical Specification S2 V2 R5 (final)
- SESAR 1 P13.02.03-D452 Technical Specification S2 V2 R5 (initial)
- SESAR 1 P13.02.03-D451 Technical Specification S2 V2 R4 (final): Multiple Constraint Resolver and GNWP
- SESAR 1 P04.07.01-D39- STEP 2 Final OSED
- SESAR 1 P04.07.01-D41- STEP 2 Final Safety and Performance Requirements (SPR)
- SESAR 1 P04.07.01-D42- STEP 2 Final Interoperability Requirements (INTEROP)

Solution PJ.09-03: Collaborative Network Management Functions

- SESAR 1 P13.02.03-D303 OSED S1 Final Update
- SESAR 1 P13.02.03-D323 SPR S1 Final Update
- SESAR 1 P13.02.03-D403 OSED S2 Final Update
- SESAR 1 P13.02.03-D423 SPR S2 Final Update
- SESAR 1 P13.02.03-D451 Technical Specification S2 V2 R4 (final): Multiple Constraint Resolver and GNWP
- SESAR 1 P13.02.03-D452 Technical Specification S2 V2 R5 (initial): Coll 4D Constraint Manager incl ASM Integration
- SESAR 1 P13.02.03-D453 Technical Specification S2 V2 R5 (final): Coll 4D Constraint Manager incl ASM Integration
- SESAR 1 P06.05.04-D16 OFA OSED 05.01.01 Edition3
- SESAR 1 P06.05.04-D19 SPR Edition2

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.09		
Source Project	Source Solution	PJ.09-01 Network Prediction and Performance	PJ.09-02 Integrated Local DCB Processes	PJ.09-03 Collaborative Network Management Functions
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨	▨
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA		▨	▨
	PJ.01-03 Dynamic and Enhanced Routes and Airspace		▨	
PJ.02 Enhanced Runway Throughput	PJ.02-08 Traffic optimisation on single and multiple runway airports			▨
PJ.04 Total Airport Management	PJ.04-02 Enhanced Collaborative Airport Performance Management			▨
PJ.07 Optimised Airspace Users Operations	PJ.07-01 AU Processes for Trajectory Definition	▨		
	PJ.07-03 Mission Trajectory Driven Processes			▨
PJ.08 Advanced Airspace Manegement	PJ.08-01 Management of Dynamic Airspace configurations		▨	
	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3		▨	
PJ.09 Advanced DCB	PJ.09-01 Network Prediction and Performance		▨	
	PJ.09-03 Collaborative Network Management Functions		▨	
PJ.10 Separation Management En-Route and TMA	PJ.10-01b Flight Centric ATC	▨	▨	▨
PJ.15 Common Services	PJ.15-01 Sub-regional Demand Capacity Balancing Service			▨
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity			▨
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories		▨	
	PJ.18-02 Integration of trajectory management processes in planning and execution		▨	
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)		▨	
SESAR1	#18 CTOT and TTA		▨	▨
	#19 Automated support for Traffic Complexity Detection and Resolution	▨	▨	
	#20 Collaborative NOP for Step 1			▨
	#21 Airport Operations Plan and AOP-NOP Seamless Integration			▨
	#46 Initial SWIM	▨	▨	▨
	#56 ATFM Slot Swapping			▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.01	PJ.04	PJ.07				PJ.08		PJ.09	PJ.16
Source Project	Source Solution	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	PJ.04-02 Enhanced Collaborative Airport Performance Management	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-03 Mission Trajectory Driven Processes	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	PJ.09-02 Integrated Local DCB Processes	PJ.16-04 Workstation, Controller productivity
PJ.09 Advanced DCB	PJ.09-01 Network Prediction and Performance			▨	▨			▨	▨	▨	
	PJ.09-02 Integrated Local DCB Processes	▨									
	PJ.09-03 Collaborative Network Management Functions	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

Dependencies with External Activities:

- FAA NextGen Programme (ATFCM Interoperability, Avionics requirements)
- FABEC and other ANSP Development Strategies
- Airbus / Boeing next Generation FMS capabilities

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

Standardization needs:

- Common Set of agreed KPIs for Network Performance Assessment
- AOP/NOP Data exchange needs

Regulatory needs:

- Rules and processes in support of multiple constraints resolution

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, Network management),
    - ATM Operational Experience (En Route, Network management),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Operations Research
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP

- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.9 Advanced Air Traffic Services – Enhanced Arrivals & Departures (PJ01)

PJ.01	Enhanced Arrivals and Departures

Problem Statement

SESAR1 focused on:

- Extending the AMAN (Arrival Manager) 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).
- Supporting coordination of traffic flows into multiple airports in the same vicinity to enable smooth delivery to the runways.
- Coupling AMAN/DMAN for traffic flow and airport operation optimisation.
- ASPA (Airborne Spacing) 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 RNAV-1 (Area Navigation-1) based procedures such as Point Merge or Trombone to provide optimal inbound and outbound flows
- Progressive implementation of procedures enabling increased use of CDO/CCO (Continuous Descent Operations/Continuous Climb Operations) in higher density traffic or from/to higher levels, optimised for each airport arrival/departure procedure
- Provision of RNP1 (Required Navigation Performance-1) SIDs (Standard Instrument Departures) and STARs (Standard Arrival Routes) and redefined holding areas, contributing to improved capacity and safety, and reduced environmental impact. Additionally, the optimisation of the route structure using A-RNP (Advanced RNP) to reduce spacing between routes.
- Use of LNAV/VNAV (Lateral Navigation/Vertical Navigation) for baro approach and LPV (Localiser Procedure with Vertical guidance) for SBAS (Satellite Based Augmentation System) and CAT-1 for GBAS (Ground Based Augmentation System) approach 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 (Demand-Capacity Balancing) within the extended horizon needs to be addressed, and potential information integration needs and balancing mechanisms need to be investigated and developed.

Complex interacting traffic flows in the TMA, including arrival flows into multiple airports in the same vicinity, need to be more actively managed to increase safety and improve fuel efficiency whilst capacity is increased. 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 can have a sub-optimal performance on some flights due to the continued necessity to use stepped climbs and descents for these 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, CO2 and NOx emissions for arriving and departing aircraft. Use of stepped climbs and descents should be reduced at the same time as optimising flights laterally and with appropriate speed management, and optimising the overall ATC task.

To further increase its benefits such as decreased controller workload and more regular flow to the runway, there is a need to continue working on ASPA-IM-S&M in order to fully validate the concept. For example, applications will need to include the use of lateral manoeuvres and will need to handle aircraft not flying direct to merge point (more complex geometry), in order to enable the spacing instruction to be given earlier.

In good weather conditions, rotorcraft operations are generally not an issue, because dedicated VFR approaches to the airport runway or Final Approach & Take-off (FATO) often enable independent aircraft and rotorcraft operations. When visual approaches are not possible, ICAO criteria for IFR FATO (Annex 14) must be used. These are very demanding in terms of protection areas, lighting and operating constraints, which limit their use. As a consequence, IFR Rotorcrafts are currently constrained to use same approach/departure procedures as fixed wing aircraft at busy airports. This negatively impacts runway throughput due to the lower speed profiles that rotorcraft have. SESAR 2020 R&D should look into how to overcome such limitations by providing rotorcraft-specific procedures that allow fixed-wing and rotorcraft to operate independently in Simultaneous Non-Interfering (SNI) operations.

Integration of Solutions

The project should address the compatibility/consistency and complementarity of solutions, both within this project and with other projects' solutions, considering technical coordination as an important aspect of each concept.

SESAR 2020 operations will require further improvements in how arriving and departing aircraft are managed compared to the baseline operation. Queue management will become more advanced, using more enhanced information and contributing to enabling more efficient and dynamic flight profiles. Multiple arrival management systems (including extended AMAN, CTA and ASAS (Airborne Separation Assistance System) Spacing) will ensure a more regular flow of arriving aircraft managed for TMA optimisation as well as runway optimisation, whilst multiple departure management systems will be used to enable a more consistent delivery of departures into the TMA and ultimately to En Route sectors. These systems will need to work together for the benefit of the TMA operation. These improved flows should help facilitate optimised profiles for aircraft, with dynamic route structures able to provide additional solutions integrated with the management of queues. Prior to ASAS Spacing industrialisation, it will be beneficial to build on quick wins supported by CDTI Assisted Visual Separation (CAVS) providing early benefits associated to relative navigation in appropriate conditions. The purpose is – when conditions permit – to provide more flexibility to improve flight efficiency and reduce the risk of a Go Around. Rotorcraft and GA (General Aviation) operations will be considered to ensure that access is improved and flights are enabled with minimal negative impact on or by commercial traffic.

Environment

In principle, all SESAR solutions should be investigated in a PCP (Pilot Common Project) environment building on what will be available at that time (around 2025), which shall be taken as baseline for performance assessment of the new solutions. Regarding Extended Projected Profile (EPP) equipage, PCP-targeted equipage rate of 45% or better is to be considered. Additional aircraft capabilities ((e.g. datalink, ADS-B (Automatic Dependent Surveillance – Broadcast), RNP…) shall be considered as relevant for each solution, with equipage rate to be agreed. Alternative environments with different equipage mixes should also be investigated to check the resilience of benefits.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

PJ.01 “Enhanced Arrivals And Departures” aims at delivering the following SESAR Solutions:

SESAR Solution PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB: 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. Investigates if and how time constraints (e.g. CTAs) could be used most optimally in high density/complexity environments. Use of SWIM (System Wide Information Management) infrastructure will be required. Addresses the interaction between Traffic Synchronisation and DCB, including the identification of integration needs

SESAR Solution PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA: Takes advantage of enhanced predicted demand information provided by local Arrival and Departure management systems to identify and resolve complex interacting traffic flows in the TMA and on the runway. A more consistent and manageable delivery of departures through user-definable TMA ‘hotspots’ (where typically two or more SIDs or STARs converge) into the En-Route phase of flight is enabled through automated support to departure metering and assistance tools provide the ability to coordinate complex interacting traffic flows within the TMA.

SESAR Solution PJ.01-03 Dynamic and Enhanced Routes and Airspace: 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. New controller tools and enhanced airborne functionalities will facilitate CDO from ToD (Top of Descent) and CCO to ToC (Top of Climb), connecting to Free Route operations. Dynamic terminal airspace accommodates differing traffic and capacity constraints (ranging from dense and complex TMAs to low demand TMAs). Fixed SID/STARs are complemented with dynamic departures/arrival routes (in Low density TMAs, (Medium density TMAs to be explored)). Parallel Approach operations are improved through the application of RNP navigation specifications and the development of enhanced ATC procedures. The need for GA/Rotorcraft-specific route types will be investigated.

SESAR Solution PJ.01-05 Airborne Spacing Flight Deck Interval Management: Validates new ASPA-IM-S&M manoeuvres including lateral manoeuvres and involving more complex geometries. The operational scope of the ASPA-FIM (Flight Deck Interval Management) (DO-195 update and the MOPS expected to be published in 2015) should be taken into account in later refinement of the plans.

SESAR Solution PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA: Further develops the Simultaneous Non Interfering (SNI) concept of operations providing procedures

SESAR Solution PJ.01-07 Approach Improvement through Assisted Visual Separation: Assisted Visual Separation (CAVS/CAPP) (CDTI (Cockpit Display of Traffic Information) Assisted Visual Separation / CDTI

Assisted Pilot Procedure).

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Assumptions

This DoW assumes that TS-0303 “Arrival Management into Multiple Airports” will be completed during Release 5 in SESAR 1. This SESAR solution aims at supporting the coordination of traffic flows into multiple airports in the same vicinity to enable smooth delivery to the runways.

This is also applicable to AOM-0705-A “Continuous climb operations (CCO)” planned initially to be addressed in Release 5.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.01-01: Extended Arrival Management with overlapping AMAN operations and interaction with DCB

Solution Description:

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 the need to consider at the same time the impact on non-arrival traffic within the sector. Network Management constraints/activities have to be considered additionally.

The interaction between Traffic Synchronization and Demand Capacity Balancing needs also to be addressed, and potential information integration needs and balancing mechanisms need to be investigated and developed. Network Management information may be incorporated into the extended Arrival Management operation in order to avoid possible negative impact generated by the AMAN constrained aircraft on other traffic and any risk of hotspots generated as a result of extended AMAN operations.

In this regard the following specific solution elements need to be considered:

- Integrating information from multiple arrival management systems operating out to extended range into En-Route sectors with local traffic/sector information and balancing the needs of each;
- Addressing the interaction between Traffic Synchronization and Demand Capacity Balancing, including identification of cross integration needs such as the integration of complexity assessment tools with traffic synchronization tools: The development of complexity calculations in TMA will require the integration of sequencing tasks derived from the use of AMAN in TMA sectors;
- Advanced AMAN criteria based on quality of service indicators, e.g. maximum delay per aircraft;
- Selection of constraints depending on aircraft feasibility, e.g. amount of delay that can be absorbed during arrival, in cruise and on the ground, depending on flight duration and aircraft characteristics.
- Enhancement of AMAN systems through utilisation of more accurate ETA (Estimated Time of Arrival) data e.g. EPP data whenever available; Passing arrival constraints to two or more upstream ANSPs to demonstrate the use of predefined delay sharing strategies, meaning how aircraft can meet the constraints and how the technical and operational issues regarding the aircraft and ANSPs associated with this process will be managed;
- Improved extended AMAN operations in adverse weather, particularly the development of coordinated scenario planning using probabilistic information and determining operational impact;
- Data sharing between participating ANSPs, with special focus at FAB (Functional Airspace Block) level, and aircraft with regard to input data to AMAN (usually aircraft Estimated Time of Arrival) and output data from AMAN in the form of suitable arrival constraints, including considerations on the type and level of detail of supporting 'environment' data, including MET information, needs to be exchanged.
- Use of suitable SWIM Infrastructure and Services
- The impact of the local linkage at an airport of the AMAN with the DMAN (Departure Manager) on the extended AMAN sequence characteristics (additional perturbations or rigidity)
- The interrelation between Traffic Synchronisation and DCB concepts related to TTA management needs to be carefully addressed and possible synergies need to be identified and validated in an integrated manner.
- Use of CTA in high density/high complexity environments is enabled through the use of improved automation and advanced ground support tools. In order to achieve high performing predictability in constrained airspace the trajectory calculation must be capable of including airspace constraints (e.g. speed restrictions/speed windows over certain waypoints, level restrictions over waypoints) and predicted wind and temperature information. It is expected that FMS (Flight Management System) capabilities need to be further developed to better respond to both ATC generated constraints and airspace/procedural constraints.
- Airborne information will be used by the ground system in determining the CTA (e.g. ETA min/max) and in monitoring its implementation.
- The solution should address how the complementarity of CTA with other operational capabilities such as ASPA-IM-S&M can be used to obtain maximum operational benefits, considering that each of the candidate solutions (e.g. ASPA and i4D/CTA) may actually not be viable 'standalone' and therefore may require such integration to deliver benefits.

This ATM Solution is identified as a potential solution for Common Services for Wave 1.

Operating environment: En-Route environment serving multiple TMA where traffic is managed by the AMAN within an extended eligibility horizon. Traffic presents various levels of bunching (including Network/DCB effects).

List of OI steps and enablers:

<table>
<tr><td rowspan="5">SOLUTION PJ.01-01
Extended Arrival Management with overlapping AMAN operations and interaction with DCB</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>V1</td><td>V2</td><td>V3</td><td></td><td></td></tr>
<tr><td>TS-0305-B “Arrival Management Extended to En Route Airspace - overlapping AMAN operations”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIMS-23</td><td>Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
</table></td><td>V2</td><td></td><td>V3</td><td></td><td></td></tr>
<tr><td>TS-0109 “Controlled Time of Arrival (CTA) in high density/complexity environment”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-11</td><td>Flight management and guidance for improved single time constraint achievement (CTA/CTO)</td></tr>
<tr><td>A/C-31a</td><td>Data link communication exchange for ATN baseline 2 (FANS 3/C)</td></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>AGDLS-ATC-AC-14d</td><td>New SPR for data link exchange of instructions or clearances related to CTA allocation (4DTRAD)</td></tr>
<tr><td>AGDLS-ATC-AC-15d</td><td>New IOP for data link exchange of instructions or clearances related to CTA allocation (4DTRAD)</td></tr>
<tr><td>AGDLS-STD-01</td><td>ICAO Provisions for ATN Baseline 2</td></tr>
<tr><td>APP ATC 148</td><td>System Support For Controlled Time of Arrival (CTA)</td></tr>
</table></td><td>V1</td><td>V2</td><td>V3</td><td></td><td></td></tr>
</table>

BTNAV-STD-02	Navigation Performance in ICAO provisions for Enhanced CTA
ER APP ATC 100	4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories
ER APP ATC 119	Enhance Air/Ground Data Communication for Step 1
ER APP ATC 149a	Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)
ER APP ATC 149b	Air-Ground Datalink Exchange to Support i4D - ETA min/max
ER APP ATC 149c	Air-Ground Datalink Exchange to Support i4D - Controlled Time of Arrival/Overflight (CTA/CTO)
ER APP ATC 160	ATC to ATC Flight Data Exchange Using The Flight Object
ER ATC 163	Support to En-route delay absorption for cross-border implementation of arrival sequence
PRO-118	ATC Procedures for use of CTA across several AoRs
REG-0100	Regulatory Provisions for Datalink Extension (DLS II)
SWIM-APS-05a	Provision and Consumption of Flight Object Sharing services for Step 1
SWIM-INFR-01a	High Criticality SWIM Services infrastructure Support and Connectivity.
SWIM-NET-01a	SWIM Network Point of Presence
SWIM-SUPT-01a	SWIM Supporting Registry Provisions
SWIM-SUPT-03a	SWIM Supporting Security Provisions
SWIM-SUPT-05a	SWIM Supporting IP Network Bridging Provisions

Identification of CNS (Communications Navigation and Surveillance) related needs

- None

Identification of MET and AIM related needs

- Individual aircraft estimated time of arrival, individual AMAN and Network DCB will use at different levels of sophistication and integration MET and AIM information. Especially valid for MET information, the data used by these individual processes is in most cases from multiple sources and of different levels of detail and overall quality. By addressing the interactions between Traffic Synchronisation and Demand and Capacity Balancing, an understanding has to be established on the sensitivity of extended arrival management on the supporting 'environment' information. It also needs to be established how this understanding will be reflected in the identification of needs for MET and AIM information to support extended arrival management.

- Enhanced flight's time predictability over a constraint point is significantly conditioned by weather. The activities to develop the anticipated solution will consider if the already defined MET information in support of CTA in SESAR1 is sufficient to meet the required performance for CTA in high density/complexity environment. Additional requirements for MET information will need to be identified when these different data- and quality-of-service- needs arise.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- The Arrival Sequence Service provides delay information on a request reply basis derived from an AMAN Service for the destination aerodrome for inbound aircraft when the holding delay is calculated to exceed a predefined minimum delay when the aircraft is a specified distance e.g.350nm from the destination aerodrome;
- Provision and Consumption of Flight Object Sharing services (e.g. Provision and consumption of ETA Min/Max and CTA web services between adjacent ANSPs when handling i4D across FIR boundaries).
- Use of suitable SWIM Infrastructure and Services. SWIM Services to be used. SWIM enabled validation platform necessary for validation needs.
- Link to step 2 SWIM enablers should be required when these are available (TS-0305-A & TS-0103, predecessors of TS-0305-B and TS-0109 are SWIM enabled).

SESAR Solution PJ.01-02: Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA

Solution Description:

This SESAR Solution aims at managing TMA traffic in near real-time, taking advantage of predicted demand information provided by Arrival and Departure management systems from one to multiple airports to identify and resolve complex interacting traffic flows in the TMA (and potentially extending into En route sectors) and on the runway, through the use of AMAN and DMAN flow adjustments and ground holdings. Effective optimisation techniques will be exploited in order to find the best possible solutions to complex traffic situations in a very short timescale.

The Solution consists of making use of enhanced arrival and departure information using SWIM compliant exchanges and provides automated support to departure metering to enable a more consistent and manageable delivery through user-definable TMA ‘hotspots’ (where typically two or more SIDs or STARs converge) into En-Route phase of flight and provide assistance tools to coordinate complex interacting traffic flows within the TMA.

A system for managing the TMA will show demand through specified airports and traffic flows, using the best available information made up from S/RBTs (Shared/Reference Business Trajectories), AMAN systems, DPI (Departure Planning Information) messages and TTOTs (Target Take Off Time) generated from a TSAT (Target Start-up Approval Time) or DMAN system and considering ‘environment’ data such as meteorological- (MET) and aeronautical-(AIM) information. This demand information will be used to:

- Improve assessment of departure delay and arrival flows;
- Enable assessment of the use of various means to match capacity to predicted demand (e.g. offload SIDs or Tactical Parallel Offsets to accommodate high departure demand along particular departure flows, or Tactical Parallel Offsets for arriving traffic);
- Resolve predicted congestion, initially by manual measures to solve imbalances and eventually by the automatic generation of an optimal set of constraints, which may for example, vary the runway sequence.

Where the ADEP (Aerodrome of Departure) is in close proximity to the FIR boundary, the system will include use of SWIM to share arrival and departure sequences between ATSUs.

Management of arrival flows into close-by airports (supported by multiple AMAN) needs to be assisted by active de-confliction with departure flows within or close to the TMA. The deployment of multiple DMANs within a TMA will provide assistance to the development of coordinated departure flows along main departure routes.

EPP information including predicted climb rates may be used as a component of DCB assessment to determine if the predicted altitudes/FLs of the subject aircraft at a waypoint mitigate the hotspot.

The Solution includes a two-step approach:

- Initially, the system will provide enhanced departure information to enable the TMA Supervisor to manually adjust the departure sequence in coordination with the TWR supervisor to enable a more consistent and manageable delivery through user-definable TMA ‘hotspots’ (where typically two or more SIDs or STARs converge) into the En-Route phase of flight;
- At a second stage, the system will provide automated support to departure metering and/or coordination of dependent traffic flows from multiple airports to enable a more consistent and manageable delivery through user definable TMA ‘hotspots’ into the En-Route phase of flight. Information exchange between the systems of proximate airports should be investigated.

Dependency is noted with this ATM Solution and ATM Solution dealing with ‘Dynamic and Enhanced Routes and Airspace’.

This ATM Solution is identified as a potential solution for Common Services for Wave 1.

Operating environment: medium and high density/complexity TMAs, including multiple small-medium airports, airspace constraints, peaks of traffic. TMA and airport environment with interactions between departures and arrivals flows.

List of OI steps and enablers:

<table>
<tr><td rowspan="5">SOLUTION PJ.01-02
Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>V2</td><td></td><td>V3</td><td></td><td></td></tr>
<tr><td>TS-0302-A “Departure Management Information from Multiple Airports”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>METEO-03</td><td>Provision and monitoring of real-time airport weather information, Step 1</td></tr>
<tr><td>METEO-04b</td><td>Generate and provide MET information services relevant for Airport and final approach related operations, Step 1</td></tr>
<tr><td>METEO-05b</td><td>Generate and provide MET information relevant for TMA and En-route related operations, Step 1</td></tr>
<tr><td>PRO-023</td><td>Procedure to identify TMA congestion and route aircraft onto offload departure routes where possible</td></tr>
</table>
▪</td><td>V2</td><td>V3</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr>
<td>TS-0302-B “Departure Management from Multiple Airports”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-41</td><td>Synchronization of departing traffic flows from multiple airports</td></tr>
</table>
.</td>
<td>V2</td>
<td></td>
<td>V3</td>
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<tr>
<td>TS-0307 “Integrated Arrival Departure Management for traffic optimisation within the TMA Airspace”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AERODROME-ATC-10a</td><td>Enhanced arrival/departure sequence with external aerodrome and CDM</td></tr>
<tr><td>AERODROME-ATC-33</td><td>Airport Demand and Capacity system enhanced to better handle arrival and departure</td></tr>
<tr><td>APP ATC 110</td><td>Enhance Arrival Management to collaborate with non-local Departure Management.</td></tr>
</table>
.</td>
<td>V2</td>
<td></td>
<td>V3</td>
<td></td>
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</tr>
</table>

Identification of CNS related needs

- None

Identification of MET and AIM related needs

- Individual DMAN and Network DCB will use at different levels of sophistication and integration MET and AIM information. And especially valid for MET information, the data used by these individual processes is in most of the cases from multiple sources and of different levels of detail and overall quality. By addressing the interactions between multiple DMAN and Demand Capacity Balancing to deliver enhanced departure metering, an understanding has to be established on the sensitivity of enhanced departure metering on the supporting ‘environment’ information. And how this understanding will be reflected in the identification of needs for MET and AIM information to support the concept.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- It is expected that this SWIM enabled solution will include AIP, NM and MET SWIM services, for example.

SESAR Solution PJ.01-03: Dynamic and Enhanced Routes and Airspace

Solution Description:

Arriving aircraft are allocated descent profiles from a selection of PBN arrival procedures which could take advantage of the aircraft ability to fly Tactical Parallel Offset. Smooth arrival flows will improve the utilisation of available airspace, reducing the need for holding and holding structures, freeing up airspace for better CCOs for departures and will reduce the risk of overload situations.

Parallel Approach operations are enhanced through the application of RNP navigation specifications (e.g. RNP AR APCH), as well as enhanced ATC procedures. In this way, alternative options for the implementation of Independent Parallel Approaches (IPA) will be provided.

Arrival flow sequencing is used to help ensure safe crossing between arrivals and departures. Notably organizing arrival traffic sequences while ensuring separation minima without penalizing aircraft (e.g. Use of EPP aircraft data, advanced RNP capabilities to design procedures or tools). An efficient strategically de-conflicted RNAV/RNP route structure is important to the solution, which will need to develop procedures that will use a layered approach based on strategic planning of the arrival sequence, which will need to be tactically fine-tuned while ensuring safe separation.

A new controller team organisation introducing an Arrival Sequencer Manager could be considered; this could be used to support A-CDO (Advanced Continuous Descent Operations). The strategic decisions should be complied with as much as possible, real-time tactical decisions/adjustments during execution not jeopardising already foreseen A-CDOs. When CDO from ToD to runway is not possible the solution will aim at limiting constraints in the aircraft descent profile and make those constraints known to airborne systems as much in advance as possible in order to allow the FMS to optimize the flight within the known constraints. Such constraints may include, for example:

- Free descent profile but constrained speed schedule
- Descent profile constrained by one or more vertical constraints along the way (to cross a waypoint at, above or below a certain level/altitude)
- Descent profile constrained by one or more vertical constraints along the way in the form or vertical windows (to cross a waypoint between two specific altitude/level constraints)

The project will research into strategic and real-time procedures to assess the impact on fuel burn of this type of partially constraint descent clearances, in order to make controllers aware of their environmental impact and support increased fuel efficiency in operations.

When the plan needs to be changed at any time, including once the descent phase of flight has started, the new ATC plan should be shared with on-board systems as soon as possible in order to allow the FMS to recalculate the most optimal descent within the new constraints. Route uplinking may be decoupled from clearance to proceed according to the uplinked route whenever issuing the clearance at uplink time is unsafe (e.g. elastic vector uplink concept). Uplinked routes may include different RNP values per flight legs (Dynamic RNP concept), as well as vertical windows at one or several waypoints for the flight to adhere to.

In low density TMAs fixed SIDs/STARs will be complemented with the ability to dynamically utilise the TMA airspace with minimal use of constraining fixes. In higher density TMAs a constraining route structure will be required, but it will be used as necessary (e.g. through dynamic use of alternative SIDs for different aircraft performance/traffic mix). Cross-integration needs of this dynamic use of airspace will be assessed, especially those related to the integration with DCB measures

Vertical and lateral profile issues in both the En-Route and TMA phases of flight are brought together with a view to creating an end to end optimised profile and ensuring transition between Free Route Airspace (FL310 and above as per the PCP) and fixed route airspace. There is a need to address how aircraft transition between FRA (Free Route Airspace) and the TMA.

The need to design procedures to meet specific GA performance issues will be examined.

This solution also includes the development of dynamic sectorisation in terminal airspace to enable effective management of all levels of operation (low, medium, high density traffic) and considers sector capacity reduction due to weather. Advanced mathematical optimisation models for defining optimal sector structures enable cost-efficient and fuel efficient operations in low density airspace and improve capacity in medium/high density operations by optimising airspace allocation and controller capacity.

Strong dependencies are noted with solutions PJ.01-01 and PJ.01-02. As a matter of fact, the concept implies to consider at a later stage integrated validations with other SESAR solutions e.g. CTA, conflict detection and resolution in TMA. A potential link is also noted with PJ.01-07, where the dynamic departure/arrival routes could incorporate transition from full IFR flight to visual separation (Assisted Visual Separation (CAVS/CAPP)) conditions.

PJ.01-03 is identified as a potential solution for Common Services for Wave 2.

Operating environment: low, medium and high density/complexity TMAs, including multiple small-medium airports, airspace constraints, peaks of traffic. TMA and airport environment with interactions between departures and arrivals flows.

List of OI steps and enablers:

<table>
<tr><th rowspan="5">SOLUTION PJ.01-03
Dynamic and Enhanced Routes and Airspace</th><th colspan="5">MATURITY</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><th></th><th>V1</th><th>V2</th><th></th><th>V3</th></tr>
<tr><td>AOM-0806 “Dynamic Management of Terminal Airspace Routes and Transition”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-13</td><td>ASM scenario management sub-system equipped with tools for assessing the impact of airspace changes on capacity</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>NIMS-50</td><td>Dynamic route finding and optimisation tool to enable optimal routes usage in the TMA</td></tr>
</table></td><td>V2</td><td></td><td></td><td></td><td>V3</td></tr>
<tr><td>AOM-0807 "Dynamic Management of Sectors in Terminal Airspace"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-13</td><td>ASM scenario management sub-system equipped with tools for assessing the impact of airspace changes on capacity</td></tr>
<tr><td>AAMS-16a</td><td>Airspace management functions equipped with tools able to deal with free-routing</td></tr>
<tr><td>APP ATC 117</td><td>Enable ATC System to Allow Dynamic Resizing of TMA Sectors</td></tr>
<tr><td>NIMS-04</td><td>ATFCM capacity planning sub-system enhanced to take into account dynamic sector shapes</td></tr>
</table></td><td>Not addressed</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
</table>

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<tr><td>NIMS-19</td><td>Flight Planning management sub-system enhanced for AFUA</td></tr>
<tr><td>NIMS-30</td><td>ATFCM scenario management equipped with tools for assessing the impact of DAC and capacity changes on trajectory efficiency</td></tr>
<tr><td>PRO-155</td><td>FCM Procedures for assessing demand/capacity vs. resources available based upon flexible airspace configurations</td></tr>
</table>
</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>
AOM-0702-B
“Advanced Continuous Descent Operations”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>ER APP ATC 120</td><td>Enhance Conflict Detection and Resolution to Use The RBT/RMT in Step 2</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
</table>
</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>
AOM-0705-B
“Advanced Continuous Climb Operations”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>ER APP ATC 120</td><td>Enhance Conflict Detection and Resolution to Use The RBT/RMT in Step 2</td></tr>
<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
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</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>
AOM-0606
“Enhanced Parallel Approach Operations using RNP”
</td><td>Not Addressed</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
</table>

Enabler Code	Enabler Title
A/C-04	Flight management and guidance for improved lateral navigation in approach via RNP
APP ATC 134	Adapt Safety Nets for Support to RNP in Approach/TMA

<u>Identification of CNS related needs</u>

- See dependencies section.

<u>Identification of MET and AIM related needs</u>

- The procedures and systems to support the management of near real-time traffic in the TMA are significantly constraint by weather. Information on the actual and predicted weather, meteorological (MET) information, will be required to support these processes and to deliver the anticipated performance improvements. Special consideration will be given to the support of 'near real-time' decision aspects of the required MET information since traditionally MET information is used in either a planning or a real-time warning context which implies different data- and quality-of-service- needs.
- To be able to correctly predict the dynamic layout of the TMA one needs to consider both the near real-time weather data and knowledge of standard weather tendencies in order to minimize utilization of TMA sectors that are prone to experience hazardous weather thus disrupting operations.

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- The definition of required SWIM services for this solution is not yet complete, however it is anticipated that EPP services, AIM and MET SWIM services shall be required.

SESAR Solution PJ.01-05: Airborne Spacing Flight Deck Interval Management

<u>Solution Description:</u>

The Solution validates the benefits, feasibility and acceptability of the new ASPA-IM-S&M manoeuvres encompassing the potential use of lateral manoeuvres and involving more complex geometries where aircraft may not be flying direct to the merge point. The operational scope of the ASPA-FIM (DO328/ED195 update and the MOPS expected to be published in 2015) should be taken into account in later refinement of the plans.

Work on airborne spacing has been performed in SESAR 1 as a continuation of previous research, and the scope has been limited to high density TMA sequencing and merging, where it competes with other SESAR solutions that deliver excellent performance. Rather than just build on SESAR 1 work, this solution is expected to review the role ASAS will play in the future SESAR environment by finding the niche for ASAS in an otherwise ground-centred concept. The ASAS-case must be based on performance expectations that may need to be assessed at V1 level if applied in new environments.

This ATM solution aims to:

- Update of the ASAS concept in order to overcome traditional blocking points that hinder performance (e.g. energy management, large number of avionics-originated unable-ASAS results).
- Analyse the impact of ASAS operations on descent profiles and flight efficiency, in order to

prevent a negative impact on fuel burn on trial aircraft.

- Analyse the relationship between ASAS and CAVS/CAPP (solution PJ01-07): transitioning between ASAS and CAVS/CAPP, potential development of hybrid concepts, etc.
- Develop complex geometry manoeuvres: aircraft landing on the same runway but coming from a different route use on parallel/near parallel runways, etc.
- Use of ASAS in adverse weather conditions (when aircraft are deviating from their assigned course for weather avoidance)
- Use of ASAS in combination with advanced separation techniques (e.g. parallel offset, elastic vector, trail/target or side-by-side climb/descent…)

Operating environment: TMA environment serving multiple airports. The above specified scenarios shall be investigated either in a traditional route structure or in airspace in which PMS or trombones are implemented.

List of OI steps and enablers:

<table>
<tr><td rowspan="5">SOLUTION PJ.01-05 –Airborne Spacing Flight Deck Interval Management</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>TS-0108 “ASAS Spacing - target not direct to a merge point (Speed and Lateral/more complex geometry)”
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-15b</td><td>Flight management and guidance for ASAS spacing with target aircraft flying not direct to metering point.</td></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>A/C-67</td><td>Onboard Traffic situation for ASPA</td></tr>
<tr><td>ADSB-0101</td><td>ICAO Annex 10 for initial ADS-B Application</td></tr>
<tr><td>AGDLS-ATC-AC-14e</td><td>New SPR for data link exchange of clearances or instructions for ASAS Spacing</td></tr>
<tr><td>AGDLS-ATC-AC-15e</td><td>New IOP for data link exchange of clearances or instructions for ASAS Spacing</td></tr>
<tr><td>AGDLS-STD-01</td><td>ICAO Provisions for ATN Baseline 2</td></tr>
<tr><td>APP ATC 144</td><td>TMA Controllers are able to issue instructions to the pilot via CPDLC messages to maintain time-based spacing against other identified aircraft</td></tr>
</table>
</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
</table>

	APP ATC 61	System Support for ASAS Spacing for Step 1					
	ASAS-0202	New SPR and IOP for ASAS Spacing Application (ED-195)					
	ASAS-STD-02	ICAO provisions for ASAS Spacing Application					
	HUM-002	New task for flight crew - spacing responsibility					
	HUM-003	Redistribution of air traffic controller task for spacing responsibility					

__Identification of CNS related needs__

- See dependencies section.

__Identification of MET and AIM related needs__

- None

__For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services__

- Not applicable for this SESAR Solution

SESAR Solution PJ.01-06: Enhanced Rotorcraft and GA operations in the TMA

__Solution Description:__

This solution aims at improving the integration of GA and rotorcraft operational within TMAs.

With the introduction of PBN concept (RNP) the route structures and automation can be optimised. In this respect GNSS (Global Navigation Satellite System) based specific procedures (PinS - Point in Space) with "Vertical Guidance" may represent a valid solution for rotorcraft, since they provide a reliable and accurate means of navigation for operations allowing the development of dedicated and tailored routes in addition to instrument flight procedures to/from airport, strategically decoupled from fixed-wing aircraft procedures, thus limiting their interference (SNI (Simultaneous Non-Interfering approach) concept) with fixed-wing operations. In addition, SBAS based navigation can enable accessibility of small airports for GA as no ground infrastructure is required.

This solution encompasses the development of:

- Dedicated PinS IFR procedures with vertical guidance (GNSS SBAS-based) designed for Rotorcraft (CAT H) which represent a valid means to guarantee access to VFR FATOs (currently only VFR operations to VFR FATO are allowed) landing locations where conventional flight procedure cannot be developed;
- PinS approach/departure procedures are instrument RNP procedures flown to/from a point-in-space. The PinS concept can provide alternative IFR capabilities to small airports where the installation of an IFR runway is not financially viable or unfeasible due to other specific constraints. The concept is also relevant for rotorcraft Simultaneous Non Interfering (SNI) operations (related OI step AO-0316 SESAR Solution PJ.02-058 in PJ.02 "Enhanced Runway Throughput"), as it enables rotorcraft specific IFR approaches/departures to/from a VFR FATO located at an airport.
- Optimised Low Level IFR route network for rotorcraft using RNP-1 / RNP-0.3" (Helicopter specific PBN specification)
- Point in space procedures allow rotorcraft access to/departure from VFR FATOs in IFR, and connection to RNP-1/RNP-0.3 low-level IFR routes dedicated to rotorcrafts. These operations might be improved by using on-board a head-mounted display that presents imagery (including

flight symbologies, enhanced vision, navigation symbologies such as the PinS itself…), facilitating the IFR-VFR transition and reducing the risk of missed approach. Use of Night Vision Goggles (NVG) attached to the HMD (Head Mounted Display) for night operations shall be considered.

- EFVS (Enhanced Flight Vision System) operations for rotorcraft using conformal Head Mounted Display and EVS (Enhanced Vision System), and to validate it on FATOs with straight-in PinS approach procedures with SBAS guidance (LPV).
- PBN departure and arrival operations for GA and rotorcraft (e.g. RNP0.3/RNP1 and radius-to-fix legs at relatively low altitudes for noise abatement and terrain clearance for rotorcraft).

This solution aims at:

- Removing IFR Rotorcraft from active runways by using Rotorcraft specific independent IFR procedures to/from FATO;
- Making Rotorcraft operations less dependent on environmental factors, such as weather, by providing easier rotorcraft access to IFR thanks to adapted routes and approach/departure procedures;
- Developing Advanced Point-in-Space procedures to ease IFR access to VFR FATOs located at airports or at remote locations (e.g. city heliport, hospital helipad). This aims to facilitate the transition from en-route to final approach segments, and vice versa for departure, in Terminal Area;
- RNP arrival and departure for GA and Rotorcraft operations.
- Developing of the legal case to support the regulatory change that may be needed in some states to allow the publication and use of IFR low level routes, SBAS/RNP approaches and RNP procedures.

Rotorcraft and GA operations require specific meteorological- (MET) and aeronautical- (AIM) information unique to the specific operational constraints imposed which is not necessarily available or shared today. As such a common operating picture between rotorcraft operations and other operations is often missing and the solutions aims to define this common operating picture and the information needs to support this.

This solution is strongly linked to solution PJ02-05, which will investigate the SNI operational concept.

Operating environment: Low, medium and High density/complexity TMAs, including multiple small-medium airports, airspace constraints, peaks of traffic.

List of OI steps and enablers:

SOLUTION PJ.01-06 – Enhanced Rotorcraft and GA operations in the TMA	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
			V3		
AOM-0104 – “Enhanced Rotorcraft Operations at VFR FATOs with specific Point-in-Space RNP approaches using satellite augmentation”.	V3 on-going		V3		

<table>
<tr>
<td>
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-01</td><td>Enhanced positioning for LPV/RNP based on Single Frequency SBAS</td></tr>
<tr><td>A/C-04</td><td>Flight management and guidance for improved lateral navigation in approach via RNP</td></tr>
<tr><td>A/C-06</td><td>Flight management and guidance for LPV approach based on SBAS</td></tr>
<tr><td>A/C-07</td><td>Flight management and guidance for RNP transition to ILS/GLS/LPV</td></tr>
<tr><td>METEO-05b</td><td>Generate and provide MET information relevant for TMA and En-route related operations, Step 1</td></tr>
<tr><td>PRO-250</td><td>Rotorcraft procedures for IFR access to VFR FATOs</td></tr>
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<td></td><td></td><td></td><td></td><td></td>
</tr>
<tr>
<td>
AOM-0810 "Integration into the TMA route structure of optimised Low Level IFR route network for rotorcraft using RNP-1/RNP-0.3"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-04b</td><td>Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach</td></tr>
<tr><td>METEO-05b</td><td>Generate and provide MET information relevant for TMA and En-route related operations, Step 1</td></tr>
</table>
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</td>
<td>V3 on-going</td><td></td><td>V3</td><td></td><td></td>
</tr>
</table>

Identification of CNS related needs

- GNSS-based e.g. APV SBAS/Baro;

Identification of MET and AIM related needs

- Rotorcraft and GA operations require specific meteorological- (MET) and aeronautical- (AIM) information unique to the specific operational constraints imposed which is not necessarily available or shared today. As such a common operating picture between rotorcraft operations and other operations is often missing. The MET and AIM information needs to support such a common operating picture or the integration of this information by support systems.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Considering the specific rotorcraft operation scenario some of them are conducted at very low level in remote areas where the ability to interface with SWIM may be limited. SWIM performances in "non-standard, non-conventional" environment (e.g. remote areas) could/should be evaluated, and the concern is when airborne for rotorcraft not fitted with data-link can use the GSM (Global System for Mobile communications) technology as enabler.

SESAR Solution PJ.01-07: Approach Improvement through Assisted Visual Separation

Solution Description:

This SESAR solution identifies and validates operational use and benefits of CDTI assisted visual separation (CAVS) and CDTI assisted pilot procedure (CAPP) applications in European operations. While the solution primarily enables aircraft to separate each other visually in marginal visual conditions (CAVS) and facilitates transitions from IFR operations to CAVS (CAPP), it is also foreseen as a potential tactical complement enabling more flexible and frequent use of other operational concepts (e.g. ASPA-IM-S&M, time based separation or RNAV procedures).

One identified potential use case is for handling approach to parallel dependent runways, in which flows to both runways can be operated as if they were independent so long as aircraft keep in sight those on the other stream that are closer to them. This prevents capacity loss due to staggered approaches. For runway pairs which are distant enough to be operated independently, it enhances safety and may eliminate the need to maintain a No Transgression Zone (NTZ) between both runways.

As per the current concept, ASPA-IM- S&M is stopped under 2000ft AAL, and there is no guarantee that the spacing between aircraft is kept down to the runway. An operation/service like CAVS could potentially be used to support flight crews in doing visual separation to keep the benefit after ASMA-IM-S&M is terminated.

Specific CAVS/CAPP pilot and controller procedures will need to be developed. Airborne procedures may need to be harmonised at a global level.

The use of visual separation between IFR aircraft in controlled airspace is possible in some countries in Europe, whereas it is not allowed in others. An important area of work for this solution is the preparation of the regulatory case that will be needed to support the necessary regulatory change to allow CAVS/CAPP operations. This evolution may include a revision of the current concept of visual separation.

Operating environment: medium and high density/complexity TMAs environment serving multiple airports

List of OI steps and enablers:

<table>
<tr><td rowspan="5">SOLUTION PJ.01-07 – Approach Improvement through Assisted Visual Separation</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td></td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
<tr><td>AUO-0507 "Airborne Spacing Monitoring under IFR (ATSAW - Spacing monitoring)"
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-15</td><td>ATSAW Spacing Monitoring</td></tr></table>.</td><td>Not addressed</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

Identification of CNS related needs

- See dependencies section.

Identification of MET and AIM related needs

- None

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- *Not applicable for this SESAR Solution*

Performance Goals

Enhanced Arrivals and Departures" objectives includes:

- 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)

Identification of impacted KPAs (Key Performance Areas) & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance and transversal areas identified below):

SOLUTION	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.01-01 **Extended Arrival Management with overlapping AMAN operations and interaction with DCB**	L	M	H		H	H		M			M	H
SOLUTION PJ.01-02 **Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA**	L	M	H		H	H		M			M	H
SOLUTION PJ.01-03 **Dynamic and Enhanced Routes and Airspace.**	L	M	H	M	H	H		H			M	H
SOLUTION PJ.01-05 **Airborne Spacing Flight Deck Interval Management**	M	M	H		M	H		M			M	L
SOLUTION PJ.01-06 **Enhanced Rotorcraft and GA operations in the TMA**	H				H	H		M	H			
SOLUTION PJ.01-07 **Approach Improvement through Assisted Visual Separation**	M	M	M	M	M	M		L	L			L

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G(Ground/Ground) or A/G(Air/Ground) integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB	**N**	This solution is addressing the link between multiple Extended Arrival management systems and Network Management, therefore involves a significant amount of G/G coordination and synchronization.
SOLUTION PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	**N**	This solution requires G/G coordination and integration of information provided by multiple local Arrival and Departure management systems and A/G coordination of aircraft downlinked trajectory information.
SOLUTION PJ.01-03 **Dynamic and Enhanced Routes and Airspace**	**N**	Use of EPP will require A/G coordination. G/G coordination will be required in circumstances where the A-CDO/A-CCO spans more than one ATSU.
SOLUTION PJ.01-05 **Airborne Spacing Flight Deck Interval Management**	**N**	The ASAS concept (FIM) requires ground as well as airborne tools and there is a need for some coordination between Air and Ground systems.
SOLUTION PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA	**L**	This SESAR Solution can be locally implemented.
SOLUTION PJ.01-07 **Approach Improvement through Assisted Visual Separation**	**N**	There should be no impact on the ground side, if considering today's operation, however in the future operation there may be a need for A/G coordination and the potential for network deployment.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Background for all Solutions:

- SESAR 1 B4.2 ConOps Step 1
- SESAR 1 B4.2 ConOps Step 2
- SESAR 1 P5.2 DOD Step 1
- SESAR 1 P5.2 DOD Step 2

Solution PJ.01-01: Extended Arrival Management with overlapping AMAN operations and interaction with DCB

- SESAR 1 P05.06.07-D27- OSED Preliminary Operational Procedures and preliminary OSED part 2 - Step 2
- SESAR 1 P05.06.07-D24- Preliminary SPR - Step 2
- SESAR 1 P05.06.07-D28- Preliminary Operational Requirements and preliminary INTEROP - Step 2
- SESAR 1 P10.09.01-D22 Consolidated Final Step 2 TS
- SESAR 1 P10.09.02-D55 Step 1 Technical Specification
- SESAR 1 P05.06.01 D83 Deliverable Step 1 - fully validated OSED
- SESAR 1 P05.06.01 D84 Deliverable Step 1 - fully validated SPR

- SESAR 1 P05.06.01 D85 Deliverable Step 1 - fully validated INTEROP
- SESAR 1 P10.09.02-D55 Step 1 Technical Specification
- SESAR 1 P04.03-D64 i4D Validation Report – Step C – VP-463 VALR
- SESAR 1 P05.06.01 D83 Deliverable Step 1 - fully validated OSED
- SESAR 1 P05.06.01 D84 Deliverable Step 1 - fully validated SPR
- SESAR 1 P05.06.01 D85 Deliverable Step 1 - fully validated INTEROP
- SESAR 1 P10.09.01-D22 Consolidated Final Step 2 TS
- SESAR 1 P10.09.02-D55 Step 1 Technical Specification
- SESAR 1 P10.09.04 D94 Step 2 technical requirements update to close out V3 (10.9.4 phase 2) – DEL
- SESAR 1 P04.03-D64 i4D Validation Report – Step C – VP-463 VALR

Solution PJ.01-02: Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA

- SESAR 1 P05.04.02-D04- Step 1 Final OSED
- SESAR 1 P05.04.02-D05- Step 1 Final SPR
- SESAR 1 P05.04.02-D06- Step 2 Initial OSED
- SESAR 1 P05.04.02-D010- Preliminary Step 2 SPR
- ISRM2.0
- P10.09.01
- P06.08.04

Solution PJ.01-03: Dynamic and Enhanced Routes and Airspace

- SESAR 1 P05.04.02-D06- Step 2 Initial OSED
- SESAR 1 P05.04.02-D010- Preliminary Step 2 SPR
- SESAR 1 P05.06.02-D05- Step 2 Advanced Concept of Operations
- SESAR 1 P05.06.02-D06- Step 2 Recommendations for Vertical Improvements through System Support Changes
- SESAR 1 P09.40 D03 Aircraft &System functional requirements for Advanced CDA and compatibility of these functions with steeper approach concept
- OPTA-INN Demonstration report
- ODP Demonstration report

Solution PJ.01-05: Airborne Spacing Flight Deck Interval Management

Solution PJ.01-06: Enhanced Rotorcraft and GA operations in the TMA

- SESAR 1 P04.10-D11 Final Operational Services and Environment Description
- SESAR 1 P04.10-D06 Validation Report – Iteration 1
- SESAR 1 P04.10-D09 Validation Report – Iteration 2

Solution PJ.01-07: Final Approach Improvement through Assisted Visual Separation

- SESAR 1 P05.06.06 D31 Stream 2 - State of the art ASPA FIM results
- SESAR 1 P05.06.06 D34 Stream 2 - Initial Validation Path (Technical Note)
- SESAR 1 P09.05 D28 Functional requirement definition of ASPA S&M - issue Stream2 (2) (Stream2 V2 validation)
- SESAR 1 P10.03.02 D54 Consolidated Requirements R4

Dependencies

Dependencies with Other SESAR Solution Projects

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1. Specifically for this project:

- PJ.15-02 Common Service providing a delay sharing capability
- PJ.01-01 identified as a potential solution for Common Services for Wave 1
- PJ.01-02 identified as a potential solution for Common Services for Wave 1
- PJ.01-03 identified as a potential solution for Common Services for Wave 2

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as *Source Solutions* are required as an input for the success of this project and its solutions.

		PJ.01				
Source Project	Source Solution	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	PJ.01-03 Dynamic and Enhanced Routes and Airspace	PJ.01-05 ASAS Spacing with more complex geometry	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA
PJ.02 Enhanced Runway Throughput	PJ.02-08 Traffic optimisation on single and multiple runway airports	▨				
PJ.06 Trajectory Based Free Routing	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace			▨		
PJ.09 Advanced DCB	PJ.09-02 Integrated Local DCB Processes		▨			
	PJ.09-03 Collaborative Network Management Functions		▨			
PJ.10 Separation Management En-Route and TMA	PJ.10-02A Improved Performance in the Provision of Separation			▨		
	PJ.10-02B Advanced Separation Management			▨		
PJ.13 Air Vehicle Systems	PJ.13-02-02 GA/R Specific Navigation Systems					▨
PJ.14 CNS	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	▨				
PJ.15 Common Services	PJ.15-02 XMAN Delay Sharing Service	▨				
	PJ.15-08 Trajectory Prediction Service	▨				
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity		▨	▨		
SESAR1	#05 Extended Arrival Management (AMAN) horizon	▨				
	#09 Enhanced terminal operations with automatic RNP transition to ILS/GLS		▨			
	#11 Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO)		▨	▨		
	#16 ASAS Spacing applications Remain behind and Merge behind				▨	
	#18 CTOT and TTA	▨				
	#21 Airport Operations Plan and AOP-NOP Seamless Integration	▨				
	#28 Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing	▨				
	#32 Free Route through the use of Direct Routing	▨	▨			
	#33 Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level	▨	▨			
	#46 Initial SWIM	▨	▨	▨		▨
	#51 Enhanced terminal operations with LPV procedures		▨			

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.02			PJ.04	PJ.06	PJ.07	PJ.09		PJ.10	PJ.13	PJ.14							PJ.15	PJ.16	PJ.18		
Source Project	**Source Solution**	PJ.02-01 Wake turbulence separation optimization	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.02-11 Enhanced Terminal Area for efficient curved operation	PJ.04-02 Enhanced Collaborative Airport Performance Management	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.09-02 Integrated Local DCB Processes	PJ.09-03 Collaborative Network Management Functions	PJ.10-01c Collaborative Control	PJ.13-02-02 GA/R Specific Navigation Systems	PJ.14-01-01 CNS environment evolution	PJ.14-02-01 FCI Terrestrial Data Link	PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	PJ.14-04-01 Surveillance Performance Monitoring	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	PJ.14-04-04 Satellite Based ADS-B	PJ.15-02 Delay Sharing Service	PJ.16-04 Workstation, Controller productivity	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	PJ.18-06 Performance Based Trajectory Prediction
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨		▨	▨	▨	▨	▨										▨		▨		
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	▨	▨		▨	▨		▨	▨											▨	▨		
	PJ.01-03 Dynamic and Enhanced Routes and Airspace			▨		▨		▨		▨		▨			▨	▨	▨			▨			▨
	PJ.01-05 Airborne Spacing Flight Deck Interval Management												▨			▨	▨						
	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA					▨					▨	▨		▨		▨	▨				▨	▨	
	PJ.01-07 Approach Improvement through Assisted Visual Separation															▨	▨	▨					

Dependencies with External Activities

Coordination undertaken with the FAA under CP4.7 (Navigation Requirements) is currently suspended.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently available standards and regulations are applicable to the work in this project:

- EUROCAE WG51/RTCA SC186 (CAVS, CAPP, ASPA-FIM SPR, ASPA-FIM and A-IM MOPS).
- EUROCAE WG85 (4D Navigation)
- EUROCAE WG 82 (New Air-Ground Data Link Technologies)

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management),
    - ATM Operational Experience (En Route, TMA, Network management),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,

  - Optimisation techniques
  - Verification methodologies,
  - MET expertise,
  - AIM expertise.
- Management and coordination:
  - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
  - Project management,
  - Quality management.
- Performance and Transversal Areas Assessments
  - Safety, security and environment performance measurement,
  - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
  - Technical expertise, knowledge and capabilities related to the European network as a whole,
  - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.10 Advanced Air Traffic Services – Trajectory based Free Routing (PJ06)

PJ.06 Trajectory 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. To meet the needs for improved capacity, flexibility and cost-efficiency, 'Full-DCT' network and network combining ATS routes and DCTs might coexist.

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.

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 for PCP.

These activities will be carried out within SESAR 2020 scope.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

Free Routing related activities in SESAR 2020 aim at realising the objective of the airspace users to plan flight trajectories without reference to a fixed route network or published directs within high & very high-complexity environments in order to provide them with significant opportunities to optimise their associated flights in line with their individual operator business needs or mission requirements.

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 the relevant SWIM functionality.

Demand & Capacity Balancing in both the planning and execution phases will have to evolve to manage the more dynamic environment including Integrated Network Management and extended ATC Planning (INAP) and Airspace Management (ASM - balancing Military & Civil airspace needs) processes.

Definition of technical specification and development of supporting system(s) for the future FOC will also need to be defined as well as, 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 exact content of PJ.06 will be adapted with the results of SESAR 1 developments and validations.

Where specific requirements emerge to enable non-mainline aircraft, such as BA, GA, rotorcraft or RPAS, then these requirements will be captured and the project will liaise with PJ.13 to coordinate appropriate technical prototype development.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security:

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.06-01: Optimized traffic management to enable Free Routing in high and very high complexity environments

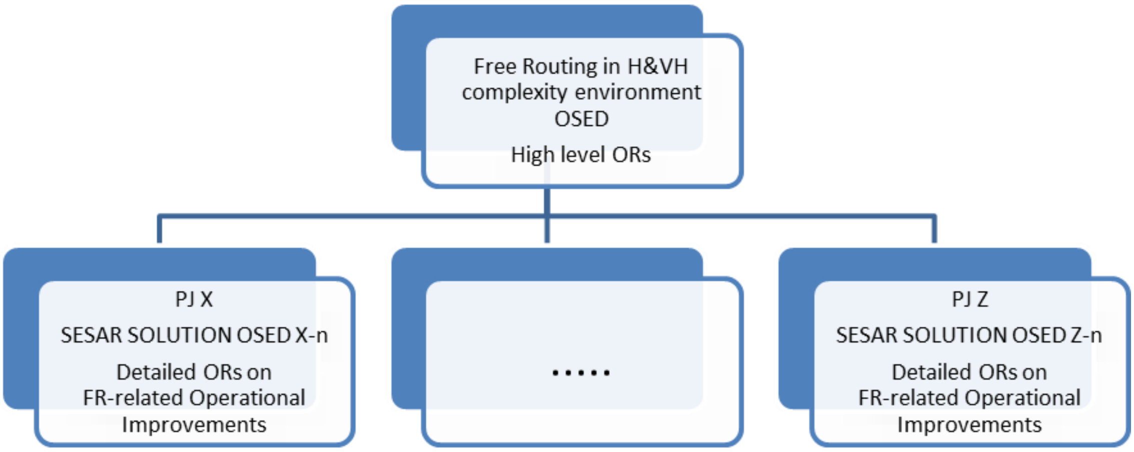
Solution Description:

The aim of this Solution is to complete research supporting delivery of PCP. This covers high and very high complexity airspace above FL310.

This SESAR Solution aims at realising the objective of the airspace users to plan flight trajectories without reference to a fixed route network or published directs within high & very high-complexity environments in order to provide them with significant opportunities to optimise their associated flights in line with their individual operator business needs or military requirements.

The result of some past studies reported that in FRA the controller workload per flight is increased. Thus, and more particularly in high and very high complexity environments, all the involved actors in Free Route operations will have to cope with a trade-off between flight efficiency and capacity. The capacity issue will have to be mitigated by several means. In order to provide elements allowing to determine the optimized trade-off between flight efficiency and capacity in FRA, this SESAR solution aims at:

- Delivering a high level OSED describing Free Routing in high and very high complexity environments through a common work (middle out process) with PJ8/9/10/11/18**.** This OSED will describe the whole scope of Free Routing operational environment and the associated high level operational requirements which will be then further refined at each project level.



- Accomplishing FTS-based performance assessment of flight efficiency and environmental impact (flight time, distance flown, fuel consumption, emissions of CO2, NOx…) in FRA extended to high and very high complexity environment.

- Validating in an **integrated way** the concept elements focused on the control team activities. Indeed, integrated validations are required to get the full picture of the Free Route traffic management in high and very high complexity environment and provide results allowing measuring how integrated ATC support tools could mitigate the loss of capacity induced by FRA.

The following aspects will be more particularly addressed:

- Separation management using enhanced CDRT (Conflict Detection & Resolution Tools incl. what if tools, and RNP capability[7]),
- Circumnavigation of active DMA (ground -ATC- and airborne -flight deck- aspects),
- Impacts of the Dynamic sectorisation concept (dynamic use of elementary airspace building blocks) on the control team.
- Impact of the free-routing environment on DCB.
- Working methods / procedures and tools to be used between the control team and the INAP actor (e.g. EAP).
- Inter ATSU coordination: tools and associated working methods/procedures including long range coordination across several ATSU (mostly in case of trajectory revision),
- Ground based safety nets.

The validation roadmaps of PJ.06 will be coordinated with those from PJ.08 and PJ.09 on one side and from PJ.10, PJ.11 and PJ.18 and PJ.15, PJ.17 on the other side in order to avoid duplications and gaps in validation activities and to ensure consistency.

Operating Environment: Free Route airspace in high and very high complexity environments with flights in cruise and vertically evolving above FL310.

List of OI steps and enablers:

Reference Dataset is DS13

<table>
<tr><th rowspan="4">SESAR Solution PJ.06-01:
Optimized traffic management to enable Free Routing in high and very high complexity environments.</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>AOM-0502 "Free Routing for Flights both in cruise and vertically evolving within high & very high-complexity environments"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-10</td><td>Modification of AOC/WOC-ATM trajectory management system (or new systems) to allow quality of service requested by NOP for pre-flight trajectory with dynamic routing</td></tr>
<tr><td>ER APP ATC 78</td><td>Enhance FDP to use 4D trajectories to support extended direct routing beyond local AoR</td></tr>
</table></td><td>V2</td><td></td><td>V3</td><td></td><td></td></tr>
</table>

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[7] Separation management using RNP in FRA is subject to airborne capacity to fly a specified RNP on user defined segments.

NIMS-21b	Flight Planning management enhanced to support 4D					
PRO-148	ASM Procedures for identifying and promulgating 'Free Route' areas					
PRO-149	Airline Operational Procedures to select the most appropriate route based upon TTA, EOBT, METEO and other operational conditions drawing from a continuously updated NOP					

Identification of CNS related needs

This SESAR solution will perform integrated validations and the required CNS needs should thus have been identified by other projects also working in FRA. These needs are a subset of the one identified in PJ8/9/10/11/18 DoWs. A preliminary list is provided hereafter and should be further coordinated during execution:

  - Enhanced Datalink capability to cope with the extensive need for air-ground exchanges,
  - Provision of accuracy monitoring for 2D RNP procedures. (Rmq from PJ06: Navigation specifications for non-published segments should be determined)

Identification of MET/AIM related needs

- MET needs:
  - In order to plan and efficiently manage the flight trajectory (including its adaptation), AOs do need access to the relevant up-to-date MET information.

- AIM needs:
  - In order to plan and efficiently manage, including the adaptation of, the flight trajectory to airspace availability, AOs do need access to the relevant and up-to-date airspace status.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

Reference: ISRM 1.2 This SESAR solution will perform only integrated validations and the required SWIM services should thus have been identified by other projects also working in FRA. These services are a subset of the ones identified in PJ8/9/10/11/18 DoWs. A preliminary list is provided hereafter and should be further coordinated during execution :

- PJ08 DoW:
  - Sharing of airspace status and DMAs type 1, type 2 and 3 via SWIM
- PJ09 DoW : SVA-009 DCB Federation Service (if relevant for information exchange in the scope of INAP) or Service(s) addressing information exchanges related to INAP (not yet described in ISRM 1.2)

- PJ10 DoW :
  - Link to Step 2 SWIM enablers may be required when these are available.
  - IOP and enhanced co-ordination messages across unit boundaries
  - MET information integrated in SWIM.

- PJ11 DoW :
    - ARESActivationService
    - ARESDeactivationService
    - SharedFlightObject
    - ATCFlightObjectControl
- PJ18 DoW :
    - Integration of military infrastructure to SWIM

- ISRM 1.2 services also relevant but not formally identified by the PJs above:
    - ATCFlightObjectControl Service
    - ControllerPilotClearance Service
    - SharedFlightObject Service

SESAR Solution PJ.06-02: Management of Performance Based Free Routing in Lower Airspace

Solution Description:

The application of Free Routing Airspace (FRA) to make available free routing for airspace users below FL310, will especially allow to:

- improve time and fuel efficiency in short haul flights of propeller driven aircrafts;
- Raise the automation level of flight planning and lessen workload of flight crew.

Flight planning in controlled air space below FL310 in most cases is connected with use of predefined airways of different classes, one-way, conditional, etc. Two contrasting groups of users may be defined:

- firstly, scheduled and unscheduled airline and cargo traffic passing by climbing or descending; and
- Further irregular but dense number of small piston or turbine aircrafts belonging to General and Business Aviation. Additionally, a moderate number of feeder airlines operating turboprop commuters may also be taken into account.

The use of defined airways, which is currently mandatory, takes place during the ground preplanning, as a result of current airspace use, strongly influenced by military and sport activities. A large amount of flight plans created in this way and approved by the ATM system exist on paper only and are not flown as planned, due to the fact that, after departure, the route is changed by ATC to improve time and efficiency. Nevertheless, the obligation to plan routes using published airways forces commanders of these aircraft to plan longer and more complex routes than might be required if such an obligation did not exist, also necessitating a heavier fuel uplift than might be required by a planned direct route. Concerning fuel economy and endurance, in some critical cases, direct distances that might be treated as one leg become two or more with intermediate landings.

This Solution would modify the planning principles for segments of users mentioned above. To minimize fuel consumption and flight time between departure and landing sites, direct routing would be taken as the norm for planning purposes. Flight Planning by the commander will be supported by an advanced planning system that utilizes information from AUP/UUPs and other sources and, having aircraft performance data, produces the most direct and efficient flight profile.

The project shall also address the integration of General Aviation and Rotorcraft.

This SESAR solution aims at:

- Enabling free-route operations below FL310.
- Evaluating state of the art in flight planning to support free route (e.g. FOC, NM, ATC).
- Reviewing traffic management solutions below FL310 in the European area;
- Analysing several critical cases of route planning with and without use of airways, focused on fuel efficiency and time;
- Analysing main traffic flows: type of airspace, FLs, airports;
- Analysing software and algorithms available;
- Analysing impact and legal issues of introduction of direct routing in various environment (FIRs), including identification of threats;
- Development and optimization of planning algorithms concerning dynamic change of AUPs or predicted SIDs, STARs and Transitions available; and
- Testing and assessment of developed software in various environments (FIRs) and proposed solution.
- Validating in an **integrated way** the concept elements focused on the control team activities. Indeed, integrated validations are required to get the full picture of the Free Route traffic management in all airspace environments.

Operating Environment: Free Route Airspace below FL310 with flights in cruise and vertically evolving.

List of OI steps and enablers:

Reference Dataset is DS13

<table>
<tr><th rowspan="4">SESAR Solution P.06-02: Management of Performance Based Free Routing in Lower Airspace</th><th colspan="5">MATURITY</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>AOM-0103 Two Categories of Airspace[8]
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AAMS-16a</td><td>Airspace management functions equipped with tools able to deal with free-routing</td></tr>
<tr><td>ER APP ATC 76</td><td>Enable systems to differentiate between different traffic type airspaces.</td></tr>
</table>
.</td><td>N/A</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
<tr><td>AOM-0502 Free Routing for Flights both in cruise and vertically evolving within high & very high complexity environments
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</table>
.</td><td>N/A</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

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[8] AOM-0103 partially addressed by this SESAR Solution with respect to its impact on Free Routing in lower airspace..

<u>Identification of CNS related needs</u>

- Navigation needs:
    - RNP capability to meet the needs of the free route environment
- Communication needs:
    - airport air-ground datalink
    - datalink services for uplink of aeronautical or MET data for use by relevant on board system
    - On board management of additional up linked data e.g. dynamic update of airspace availability
    - Communication interface to send route information to partner systems

<u>Identification of MET/AIM related needs</u>

- MET needs:
    - In order to plan and efficiently manage the flight trajectory (including its adaptation) to weather, AOs do need access to the relevant up-to-date MET information.
- AIM needs:
    - Access to current AIM data to support flight planning
    - Access to relevant NM data to support trajectory planning and negotiation

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

This solution requires following SWIM services (including these specified in ISRM 1.2)

- Civil – Military dynamic data exchange
- SWIM services:
    - Meteorological data (AIRPORTMETFORECAST, AIRPORTMETOBSERVATION, METAR, TAFSERVICE, SNOWTAM, WINDSALOFTINFORMATION, METEOROLOGICALINFORMATIONNOTIFICATION);
    - Flight management data (ARRIVALMANAGEMENTINFORMATION, REPORTAIRCRAFTTRAJECTORY, REPORTAIRCRAFTETAMINMAX);
    - Flight planning data (AERONAUTICALINFORMATIONFEATURE, NETWORKOPERATIONPLAN, EXTENDEDFLIGHTPLANSUBMISSION, EXTENDEDFLIGHTPLANDISTRIBUTION, EXTENDEDFLIGHTPLANSTATUS, OATFLIGHTPLANSUBMISSION SERVICE).

Performance Goals

PJ.06-01 "Optimized traffic management to enable Free Routing in high and very high complexity environments" objectives includes:

- Improved Predictability: In current operations the trajectory actually flown (putting aside the arrival phase) is statistically significantly shorter than the trajectory planned in pre-flight phase.

By enabling AUs to plan and fly a trajectory closer to their business needs, Free Routing will improve predictability. This will be even more the case with a FRA widened as made available in high and very high complexity environment.

- Improved Environmental Sustainability / Flight Efficiency: An enlarged FRA will directly lead to improved flight efficiency in both fuel efficiency and business/mission effectiveness
- Improved Access and Equity as making Free Route available in high and very high complexity environment will allow operating Free Route at lower levels than previously studied and enabling access to a larger number of aircraft type (incl. piston, turbo prop…)

Moreover, the following KPA are impacted by Free Route operations, but this impact is aimed to be mitigated by the use of the ATC support tools:

- En-Route Capacity maintained or improved. The result of some past studies reported that in FRA the controller workload per flight is increased. This result might be mitigated by the advanced ATC support tools available in SESAR 2020. The capacity figures will be carefully studied during the validations. If need be, the trade-off between flight efficiency and capacity might be validated in order to guarantee the required safety level.
- Safety maintained or improved. Even if the traffic could be more complex in FRA than on an ATS Route Network, ATC tools (e.g. CDT, MONA…) should mitigate this impact (see above).
- Human Performance: Previous studies shown that ATCO situation awareness might be negatively impacted by Free Route; this negative impact is mitigated by the use of support tools (e.g. trajectory editor).

To finish, interoperability is also addressed as FRA supported by this SESAR solution will be extended to a larger geographical level and interoperable systems will be required to operate this airspace (needs of G/G and A/G interoperability). In addition this SESAR solution will enable a seamless ATC Service delivery in FRA and the geographical uniformity of this service.

PJ.06-02 “Management of Performance Based Free Routing” objectives includes:

- Improved predictability and efficiency for a wide range of different airspace users, therefore improved Access and Equity including BA/GA and rotorcraft.
- As flexibility of airspace is predicted, and availability of airspace is constantly updated, more flights can be handled, and throughput of airspace is increased. Therefore cost effectiveness is increased.
- Lower fuel consumption for an aircraft in pre-departure & flight phase will allow increasing flight efficiency.
- Human performance affects two groups of stakeholders, but in different way. The Solution will increase significantly positive cockpit crew performance, reducing their fatigue, but also may decrease abilities of ATC services due to the fact of higher workload. This may also affect other KPAs consequently.
- FRA coupled with reducing airspace complexity will increase interoperability.
- Safety maintained or improved.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.06-01 **Optimized traffic management to enable Free Routing in high and very high complexity environments.**	[9]	**H**	**M**	**H**	[10]	[11]		**M**	**L**		**M**	
SOLUTION PJ.06-02 **Management of Performance Based Free Routing in Lower Airspace**	**M**	**H**	**M**	**H**	**L**	**M**		**M**	**M**	**L**	**M**	**L**

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G(Ground/Ground) or A/G(Air/Ground) integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.06-01 **Optimized traffic management to enable Free Routing in high and very high complexity environments.**	**N**	This SESAR solution aims at extending FRA in high and very high complexity environment, in order to pursue the deployment of FRA at a large geographical scale, it is thus by definition a Network wide solution, with requirements on G/G and A/G integration.

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[9] See PJ.06-01 – Performance goal description above

[10] See PJ.06-01 – Performance goal description above

[11] See PJ.06-01 – Performance goal description above

SOLUTION PJ.06-02 **Management of Performance Based Free Routing in Lower Airspace**	N	Both A/G and G/G coordination of relevant services and dynamic information interchange will be required.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.06-01: Optimized traffic management to enable Free Routing in high and very high complexity environments

- SESAR 1 P04.07.02-D38- Free Route OSED_3
- SESAR 1 P10.04.01 D78 Conflict Detection and Resolution Tools System Requirements Refinement- R5
- SESAR 1 P10.04.02 D44 Consolidated conformance monitoring system requirements
- SESAR 1 P10.04.03 D44 Final Technical Specifications
- Some initiatives where FRA is implemented in low to medium complexity environments. (e.g. DK-SE FAB, Finland, Ireland …)
- SESAR 1 P07.05.03 OSED – D33
- SESAR 1 P07.05.03 Validation Report - D35SESAR 1 P04.07.02 Free Route OSED Iteration 3 - D36
- SESAR 1 P04.03 D81 VP797 Validation Report and D83 VP798 Validation Report
- SESAR 1 P07.05.04 Dynamic Airspace Configuration S2V2 OSED – D 53
- SESAR 1 P07.05.04 VP718 and VP755 Validation Report
- SESAR Demonstration “Free Route Airspace Maastricht and Karlsruhe (FRAMaK)” Final Report
- Free Solutions LSD Demonstration Report

Solution PJ.06-02: Management of Performance Based Free Routing in Lower Airspace

- OFA 03.03.01 OSED, SPR, INTEROP
- SESAR 1 P04.07.02-D38- Free Route OSED_3
- SESAR 1 P10.04.01 D78 Conflict Detection and Resolution Tools System Requirements Refinement- R5
- SESAR 1 P10.04.02 D44 Consolidated conformance monitoring system requirements
- SESAR 1 P10.04.03 D44 Final Technical Specifications
- SESAR 1 P07.05.03 OSED – D33
- SESAR 1 P04.03 D81 VP797 Validation Report and D83 VP798 Validation Report
- SESAR 1 P07.05.04 Dynamic Airspace Configuration S2V2 OSED – D 53
- SESAR 1 P07.05.04 VP718 and VP755 Validation Report

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.06	
Source Project	**Source Solution**	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA		▨
	PJ.01-03 Dynamic and Enhanced Routes and Airspace		▨
	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA		▨
PJ.07 Optimised Airspace Users Operations	PJ.07-02 AU Fleet Prioritization and Preferences	▨	
PJ.14 CNS	PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS	▨	
	PJ.14-04-01 Surveillance Performance Monitoring	▨	▨
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity	▨	▨
SESAR1	#28 Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing	▨	▨
	#32 Free Route through the use of Direct Routing	▨	▨
	#33 Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level	▨	▨
	#46 Initial SWIM	▨	▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.01	PJ.07			PJ.08	PJ.10	PJ.14			PJ.16
Source Project	**Source Solution**	PJ.01-03 Dynamic and Enhanced Routes and Airspace	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.08-01 Management of Dynamic Airspace configurations	PJ.10-01b Flight Centric ATC	PJ.14-02-01 FCI Terrestrial Data Link	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	PJ.14-04-01 Surveillance Performance Monitoring	PJ.16-04 Workstation, Controller productivity
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.		▨	▨	▨	▨	▨	▨	▨	▨	▨
	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace	▨								▨	▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

None at the present time.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently applicable standards and regulations are applicable to the work in this project.

Solution PJ.06-01: ‘Optimized traffic management to enable Free Routing in high and very high complexity environments’:

In order to operate FRA in high and very high complexity environment the standards/regulations addressing the following items might require to be amended:

- Flight Plan data (FIXM/FF-ICE)
- G/G and A/G interoperability
- Definition of the notion of ATC sector
- Need for non-geographical controller validation

Solution PJ.06-02: ‘Management of Performance Based Free Routing in Lower Airspace’:

FR in the range of altitudes covered in solution PJ.06-02 should have unified ICAO airspace class. Currently, depending on FIR, the class varies from C to E, which implies different approaches for flight planning and management. The Solution would recommend for Eurocontrol/EASA the most suitable airspace arrangement for the best FR solution.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management),
    - ATM Operational Experience (En Route, TMA, Network management),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (ATC, CNS, Flight Operations Center, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

Solution PJ.06-01: Free Routing for Flights both in cruise and vertically evolving within high & very high-complexity environments.

- This SESAR Solution will deliver a high level OSED which will then be used as input by other identified projects (cf. Dependencies section) to produce their deliverables. This OSED will be updated with the validation results from these projects and the integrated validation results.
- SPR

Moreover, the following deliverables related to integrated validations activities will be produced:

- TS/ IRS of the impacted systems
- VALP/VALR
- Cost benefit assessment
- Communication Plans and results

Solution PJ.06-02: Management of Performance Based Free Routing in Lower Airspace.

The premier outcome of this SESAR Solution are methodologies and algorithms of free route flights from planning phase up to execution in high- complexity environments. Tools for other projects for further validation will be delivered.

This will be disseminated, inter alia, in the form of:

- Cost Benefit Assessment of FR implementation, especially in the segments dominated by BA/GA/Rotorcraft/RPAS traffic;
- OSED concerning FR in the lower airspace;
- SPR for FR implementation;
- VALR

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.11 Advanced Air Traffic Services – Separation Management En-Route and TMA (PJ10)

PJ.10	Separation Management En-Route and TMA

Problem Statement

Today's operation within continental En-route and TMA 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 required to be 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.

Finally, the flight efficiency in oceanic and other En-route areas without radar coverage is negatively affected by applied procedural separation methods frequently resulting in inefficient flight profiles of involved aircraft.

Future En-Route and TMA environment is anticipated to be even more loaded and complex, and substantially different from the Step 1 situation, as full business and mission trajectories will be used.

It is needed to suit e.g. free route operational environment and mixed mode operations based on RNAV and RNP specifications. In addition new system functionalities and further steps of automation provide the chance to achieve significant operational benefits with regards to safety, capacity/productivity and cost-efficiency. New ATC tools and the development of new concepts are also required, to allow for different controller team and sector structures to suit various airspace structures like free route, various traffic levels and complexities. Also the need for higher controller productivity needs to be addressed with new team organisations in order to decrease ATC related costs.

The separation management concepts developed in SESAR 1 have, in some cases, required development of an underlying trajectory prediction capability to generate the trajectories required to support conflict detection, conflict resolution, 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 FOC data together with EPP (Extended Projected Profile) and DAPs (Downlink of Aircraft Parameters) into ground-based trajectories
- Use of trajectory Quality of Service information such as uncertainty

RPAS

Remotely Piloted Aircraft Systems (RPAS) that are to operate under VFR or IFR will have to integrate into an environment which is dominated by manned aviation.

This "Airspace Access and Airport operations" activity addresses the consequential airspace and airport integration aspects, such as, minimum performance requirements for IFR/VFR flights, separation criteria (e.g. wake turbulence, the impact of latency) and other ATM requirements.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

The solutions within this project look at the tactical layer of separation management. For resolution advisory purposes demand and capacity balancing considerations will be taken into account if it is feasible, but the main objective is aiming at the provision of separation between aircraft.

The definition of new responsibilities of each player, 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 minimising the number of critical incidents despite increasing traffic. Emphasis will be put on increased cost efficiency measures during the validation of new sector team organizations.

It is expected that the ground-based trajectories will include the incorporation of increasing amounts of airborne data and data from other sources. Also the use of enhanced airborne capabilities like 2D RNP and the systemized use of vertical and time constraints for separation purposes will be validated.

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:

a) Enhancement of SESAR 1 delivered assistance tools through an improvement of their performances, e.g.

- enhanced ground TP;
- shared information;
- EPP and DAP aircraft derived data;
- meteorological data (e.g. improved wind predication and convective weather zone prediction); and
- integration of ASM and mission trajectory data.

b) Addition of new functionalities, e.g.

- automatic detection of conflicts (including wake vortex);
- civil/military coordination;
- block level conflict detection to support cruise climb;
- removal of boundary co-ordinations; and
- on board ASAS supporting ATC tasks.

c) Validation of new separation aids by providing new ATC assistance and automated support tools for En-Route and TMA environment, e.g.

- CD & CR tools;
- conflict resolution advisory tools; and
- conformance and Aircraft Intent Monitoring.

d) 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 while taking into account intrinsic uncertainty in the trajectory:

- different team organisation for multi sector planning with different assignments of responsibilities including improved handover procedures;
- validation of the integration of new ATC separation management functionalities where applicable;
- impact of the value provided by RNP specifications (as defined in the ICAO PBN Manual) to radar separation minima; and
- consideration of roles and responsibilities between Local ATFCM and ATC.

e) Validation of Flight-centred ATC in En-Route environment where a number of flights are assigned to an ATCO, unconstrained by geographical location, sector or national boundaries:

- validation of procedures for conflict detection and resolution;
- validation of increase of controller productivity; and
- consideration of procedures for flight optimization and harmonization with local ATFCM.

f) Validation of ASAS separation (cooperative separation)

- delegation of separation responsibility;
- transfer of corresponding separation task to the flight crew; and
- consideration of key applications “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.

All envisaged solutions include Fixed Routing and Free Routing environment, where ATC operations become less dependent to structured route organisation and much more dependent on flight monitoring, conflict detection and resolution tools. The work achieved in SESAR 1 with Free Routing above FL310 will be extended also to lower Flight Levels.

The project will consider how the solutions could apply to non-mainline AUs, such as GA, BA and rotorcraft and, where specific requirements are identified, coordinate closely with PJ.13 to develop appropriate technical solutions.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.10-01a: High Productivity Controller Team Organisation

Solution Description:

This Solution develops concepts of operation and identifies the nature of system support required for operating in team structures that are not the usual Planner-Executive (1P-1E) two-person ATC sector team. In particular, the combined role for Single Person Operations (SPO) and the Multi-Sector Planner (MSP) where a Planner has responsibility for the airspace under the executive control of two or more independent Executive Controllers (1P-nE).

The Solution focuses on the typical one Planner to several Executive Controllers MSP organizations and concentrates on the efficient and safe distribution of responsibility for traffic and separation management across the team. The role of the MSP can be seen as a “local complexity manager” whose responsibility is to plan efficient flight profiles through the airspace sectors under his control as well as ensuring the efficient distribution of workload across the Executive Controllers. Demand and capacity balancing considerations are taken into account if feasible, but the main objective aims at the tactical provision of separation between aircraft. To this end the MSP is able to adjust flight profiles and/or the internal (executive) sector boundaries so that workload is balanced between the Executives (this might be the adjustment of either vertical or lateral boundaries).

In the upper air, the MSP team supports an operation tending towards free-route concepts while in the lower air and particularly TMA operations, a more systemized operation is developed to improve predictability and capacity through reduced tactical intervention.

Operating Environment:

Low/medium/high complexity En-Route and TMA environments. The airspace structure analysed within this solution will be the fixed route and free route environment.

The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights. Military flights will be supported as long as they are treated as GAT traffic.

Harmonization and integration aspects with local ATFCM processes need to be taken into account.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.10-01a
High Productivity Controller Team Organisation</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0303 "Sector Team Operations Adapted to New Responsibilities in En route, 1 Planning to several Tactical Controllers team structure
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 96</td><td>ATC System Support to Permit a Single Planner Role Associated to Multiple Tactical Roles and Single Person Operations</td></tr>
<tr><td>HUM-005</td><td>New staffing configuration/ Single Person Operation</td></tr>
</table>
.</td><td>V1</td><td>V2</td><td>V3</td><td></td><td></td></tr>
<tr><td>CM-0304 "Sector Team Operations Adapted to New Responsibilities in the TMA, 1 Planning to several Tactical Controllers team structure"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 96</td><td>ATC System Support to Permit a Single Planner Role Associated to Multiple Tactical Roles and Single Person Operations</td></tr>
<tr><td>HUM-006</td><td>New staffing configuration/ Extended ATC Planner in TMA</td></tr>
</table>
.</td><td>V1</td><td></td><td>V2</td><td>V3</td><td></td></tr>
</table>

Identification of CNS related needs

- None.

Identification of MET/AIM related needs

- None.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

SESAR Solution PJ.10-01b: Flight Centric ATC

Solution Description:

This solution encompasses the investigation of Flight-centred ATC for two different environments:

- low complexity environment; and

- medium and high complexity environment.

The idea to dissolve sector boundaries and to have one controller in charge for a single flight to guide it through a large airspace.

As a basic principle of flight-centred ATC, a controller is no longer in charge of managing the entire traffic within a given sector. Instead, he is now responsible for a certain number of aircraft throughout their flight segment within a given airspace whereas other controllers are responsible for a certain number of different aircraft within the same airspace. This way of traffic control does not change the basic responsibilities given to the controller: The basic task of the controller remains untouched: he has to ensure a conflict-free flight.

It is expected this SESAR Solution addresses, amongst others, the following topics:

- transition strategies from current to flight-centred ATC;
- integration of RPAS, GA, rotorcraft, and military users;
- inter-Controller Coordination;
- assignment of aircraft to controller, primarily to enable an even workload distribution among controllers and to reduce the probability of having more than one conflict situation at the same time;
- medium-term conflict detection based on 4D trajectories;
- harmonization and integration of local ATFCM processes (dynamic DCB);
- priority and De-confliction rules;
- advanced controller working tools
  - what-if/what-else conflict probing;
  - conflict Resolution Advisories;
- safety aspects
  - severe weather procedures;
  - fall-back for system degradation;
  - emergency procedures;
- controller Working Position
  - traffic situation displays;
- communication
  - Air-Ground Datalink; and
  - Geographically Independent Voice Communication.

Operating Environment:

Low complexity En-Route Environment, Upper Airspace; Medium/high complexity En-Route Environment (depending on OI-step). The airspace structure analysed within this solution will be the fixed route and free route environment.

The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights. Military flights will be supported as long as they are treated as GAT traffic.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.10-01b
Flight Centric ATC</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>CM-0200-B "Flight-centred ATC in Non-Geographically-Constrained, Low complexity En-Route environment"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-31a</td><td>Data link communication exchange for ATN baseline 2 (FANS 3/C)</td></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>ER APP ATC 103</td><td>Enhance Monitoring Aids to Use RBT/RMT Constraints and Commitments in Step 2</td></tr>
<tr><td>ER APP ATC 120</td><td>Enhance Conflict Detection and Resolution to Use The RBT/RMT in Step 2</td></tr>
<tr><td>ER ATC 100</td><td>ATC System to Support Flight-Centered ATC In Enroute</td></tr>
<tr><td>HUM-017</td><td>New working methods for operation within FC-ATC Environment</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
</table>
.</td><td>NA
(V1 outside SESAR 1)</td><td></td><td></td><td>V2</td><td>V3</td></tr>
<tr><td>CM-0200-C "Flight-centred ATC in Non-Geographically-Constrained Medium and High Complexity En-Route environment"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>CTE-C02</td><td>A/G Datalink radio</td></tr>
<tr><td>CTE-C01b</td><td>New Digital A/G Voice</td></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>APP ATC 99</td><td>ATC System to use Real-Time Meteo Information Received From Met Systems</td></tr>
<tr><td>ER APP ATC 157</td><td>ATC System Support for Medium-Term Conflict Detection and Resolution in En-route Airspace</td></tr>
</table>
.</td><td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
</table>

NOTE : the list of enablers should be further updated in the frame of DS15

Identification of CNS related needs

- Air Ground Datalink

- Geographically Independent Voice Communication
- Inter-Controller Communication

<u>Identification of MET/AIM related needs</u>

- Accurate weather forecast

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- Blue profile services defined in SESAR 1

SESAR Solution PJ.10-01c: Collaborative Control

<u>Solution Description:</u>

The solution results in a concept of operation for Collaborative Control (i.e. co-ordination by exception rather than co-ordination by procedure) and determines to which environments it is best suited and may be facilitated thanks to advanced controller tools.

With this Solution concepts such as release-on-contact, “porous” sector boundaries, sharing of airspace, flight intent and Controller intent are all investigated and support reduced need for co-ordination agreements (so reduced workload), fewer boundary constraints (so improved aircraft profiles), the application of constraints to aircraft trajectories at the point where the particular separation resolution is needed (which may be mid-sector rather than on the boundary), the ability to combine sectors into Multi-Sector Planner teams (enhancing the concepts in developed in Solution 1a).

<u>Operating Environment:</u>

Low/medium/high density and complexity En-Route and TMA environments.

The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights. Military flights will be supported as long as they are treated as GAT traffic. Harmonization and integration aspects with local ATFCM processes need to be taken into account.

<u>List of OI steps and enablers:</u>

<table>
<tr><td rowspan="4">SOLUTION PJ.10-01c
Collaborative Control</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0305 "Sector Team Operations Adapted to New Responsibilities and Operating Procedures involving reduced Coordination in the TMA"
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>ER APP ATC</td><td>ATC System Support to Adapted Sector</td></tr></table></td><td>V2</td><td></td><td></td><td></td><td>V3</td></tr>
</table>

<table>
<tr>
<td><table><tr><td>102</td><td>Team Roles Based on Flexible Collaboration of Tactical Controllers Supported by a Single Planner</td></tr></table>.</td>
<td></td><td></td><td></td><td></td><td></td>
</tr>
<tr>
<td>CM-0306 "Sector Team Operations Adapted to New Responsibilities and Operating Procedures involving reduced Coordination in En route"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>ER APP ATC 102</td><td>ATC System Support to Adapted Sector Team Roles Based on Flexible Collaboration of Tactical Controllers Supported by a Single Planner</td></tr></table>.</td>
<td>V1</td><td></td><td>V2</td><td></td><td>V3</td>
</tr>
</table>

<u>Identification of CNS related needs</u>

- None.

<u>Identification of MET/AIM related needs</u>

- None.

<u>For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services</u>

- IOP and enhanced co-ordination messages across unit boundaries.

SESAR Solution PJ.10-02A: Improved Performance in the Provision of Separation

<u>Solution Description:</u>

This SESAR solution aims at improving the provision of separation (tactical layer) in the en-route and TMA operational environments. Vertical and longitudinal separation are ensured by tactical ATC intervention; however these instructions are limited as much as possible through the use of enhanced tools and aircraft data which allows predicting with low uncertainty the present and future aircraft positions. Conformance monitoring assists the controller in maintaining situational awareness and relieving him from routine tasks.

Controllers are assisted in their separation tasks by the following technical functionalities:

- improved ground trajectory prediction using the following input data:
    - ATC intent based on existing lateral and vertical clearances (already delivered to the aircraft or not) that are known by the ground system (e.g. cleared flight level and open loop lateral clearances - open headings – which are registered in the ground system through the elastic vector concept);
    - Airborne intent (e.g. ADS-C EPP - predicted climb and descend speeds, the predicted CAS/Mach conversion altitude and potentially predicted vertical rates dependent on the altitude);
    - Integration of input data derived from meteorological services (e.g. the actual wind data derived from Mode S enhanced data and possibly other data sources);
- detection of conflicts based upon ground trajectory prediction;

- resolution support based upon ground trajectory prediction and conflict detection for potential controller action (e.g. what-if and what-else probing) with consideration of a wide variety of controller actions (e.g. “be at level at position”, “pass position at time”, climb or descend with a certain rate);
- provision of the capability for early automatic conflict dilution (e.g. through automatic allocation of CTOs or speeds to conflicting aircraft around the conflict point);
- conformance Monitoring: Indication if aircraft deviate or will potentially deviate from the calculated ground system trajectories;
- proposal of new aircraft trajectory to resolve predicted conflicts or complex situations, for the planner controller, that could generate new trajectory to be transmitted to the aircraft or to be managed by the tactical controller; and
- analysis of subtle navigation factors which can be obtained from mining collected surveillance data.

For the detection of potential conflicts and the resolution support both surveillance separation and wake vortex separation are taken into account.

Operating Environment:

This solution applies to the operational environment of the En-Route and TMA airspaces. It comprises upper and lower high and medium complexity En-Route airspace and also approach airspace of medium and high complexity airports, En-route sectors that primarily serve traffic to approach units (enhanced TMA) or with a high portion of approaching traffic to airports without dedicated approach unit.

The airspace structure analysed within this solution will be the fixed route and the free route environment. 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 where airspace reservations are managed in accordance with AFUA principles. There will be the possibility to provide user preferred routes as well in the flight plan and upon pilot’s request.

The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights. Furthermore different equipage has to be taken into account with regards to 2D RNP equipage. Military flights will be supported as long as they are treated as GAT traffic. Civil/military co-ordination in the sense that both military and civil aircraft will be controlled within the same airspace will be assumed.

A/G communication will take place via R/T. CPDLC services may also be available for this solution.

For this solution the controller team will work in the traditional one tactical - one planning team organisation.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.10-02A
Improved Performance in the Provision of Separation</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0209 "Conflict Detection and Resolution in En Route using trajectory data in Predefined and User Preferred Routes environments"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>ER APP ATC 100</td><td>4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories</td></tr>
<tr><td>ER APP ATC 104</td><td>Adapt Controller Tools to Use Enhanced Trajectory data</td></tr>
<tr><td>ER APP ATC 149a</td><td>Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)</td></tr>
<tr><td>ER APP ATC 160</td><td>ATC to ATC Flight Data Exchange Using The Flight Object</td></tr>
<tr><td>ER APP ATC 82</td><td>Enhance FDP to use SBT/SMT, RBT/RMT</td></tr>
<tr><td>ER ATC 94</td><td>ATC tools in support of RNP (e.g. RNP1, A-RNP) for En Route</td></tr>
</table>
.</td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
<tr><td>CM-0210 "Ground Based Flight Conformance Monitoring in En Route using Trajectory Data"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-04a</td><td>Flight management and guidance for Advanced RNP</td></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>CTE-S03b</td><td>ADS-B station for RAD and APT surveillance (ED-102A)</td></tr>
<tr><td>ER APP ATC 100</td><td>4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories</td></tr>
<tr><td>ER APP ATC 104</td><td>Adapt Controller Tools to Use Enhanced Trajectory data</td></tr>
<tr><td>ER APP ATC 149a</td><td>Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)</td></tr>
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</td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
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<tr><td>ER APP ATC 160</td><td>ATC to ATC Flight Data Exchange Using The Flight Object</td></tr>
<tr><td>ER ATC 94</td><td>ATC tools in support of RNP (e.g. RNP1, A-RNP) for En Route</td></tr>
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<tr><td>A/C-11</td><td>Flight management to include single time constraint management (CTO, CTA)</td></tr>
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<tr><td>ER ATC 162</td><td>Ground ER ATC system is able to assign CTO to flights for early conflict resolution</td></tr>
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<tr><td></td><td>management in En-Route using RNP specifications</td></tr>
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CM-0206 "Conflict Detection and Resolution in the TMA using trajectory data"
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<td>V1</td><td>V2</td><td></td><td>V3</td><td></td>
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Identification of CNS related needs

- Surveillance provision taking into account different separation minima – as of today
- A/G data link for the provision of the ADS-C EPP service, possibly CPDLC (if available) and CTA/CTO exchange
- R/T communication – as of today
- Provision of accuracy monitoring for 2D RNP procedures

Identification of MET/AIM related needs

- Mode S enhanced surveillance availability – as of today
- Accurate weather forecast to improve trajectory precision

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Blue profile services defined

SESAR Solution PJ.10-02B: Advanced Separation Management

Solution Description:

This SESAR Solution aims at increasing the quality of services of separation management in the en-route and TMA operational environments (e.g. reduce control workload, reduce separation buffers, facilitate new controller team organisation) by introducing automation mechanisms (e.g. vertical and longitudinal separation are ensured by interventions recommended by the automated system that have to be confirmed by controllers and in exceptional cases by controller intervention).

Controllers are assisted in their separation tasks by technical functionalities using advanced data that increase the quality of provided services. Some examples below:

- Improved ground trajectory prediction using the following input data:
    - ATC intent based on existing lateral and vertical clearances (already delivered to the aircraft or not) that are known by the ground system (e.g. the complete flight profile, cost index and weight considerations);
    - full integration of ground trajectory constraints within the air trajectory;
    - airborne intent (e.g. ADS-C EPP - predicted climb and descend speeds, the predicted CAS/Mach conversion altitude and potentially predicted vertical rates dependent on the altitude); and
    - integration of input data derived from meteorological services (e.g. advanced wind consideration, taking into account a now cast wind field derived from actual wind data from aircraft Mode S enhanced surveillance data, consideration of “no fly” zones provided by meteorological services).
- Resolution support based upon ground trajectory prediction and conflict detection providing effects on flight efficiency in order to allow for prioritisation. This may be facilitated through:
    - controllers obligation to confirm each recommended intervention;
    - closed-loop trajectory revision (i.e. elastic vector) uplinked to the aircraft without necessarily up-linking the corresponding clearance at the same time;
    - simultaneous clearances uplink rather than use open-loop vectors; and
    - consideration of the PBN specification of the aircraft involved in the encounters and

classification of the nature of the encounters appropriately.

- Provision of the capability for early automatic conflict dilution applied to mixed equipped fleet comprising non-equipped and equipped aircraft.
- Conformance Monitoring: Shared aircraft trajectory (e.g. EPP, Mode S enhanced surveillance information) will also be checked against the calculated ground system trajectories.

Operating environment:

This solution applies to the operational environment of the En-Route and TMA airspaces. It comprises upper and lower high and medium complexity En-Route airspace, as well as approach airspace of medium to high complexity airports.

The airspace structure analysed within this solution will be the fixed and the free route environment.

The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights. Furthermore different equipage has to be taken into account with regards to 2D RNP equipage. Military flights will be supported as long as they are treated as GAT traffic. Civil/military co-ordination in the sense that both military and civil aircraft will be controlled within the same airspace will be assumed.

A/G communication will take place via R/T. CPDLC services will also be available for this solution.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.10-02B
Advanced Separation Management</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0207-B "Automated Ground Based Flight Conformance and Intent Monitoring in En Route in Step 2"
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<tr><td>ER APP ATC 103</td><td>Enhance Monitoring Aids to Use RBT/RMT Constraints and Commitments in Step 2</td></tr>
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.</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>CM-0403-B "Early Conflict resolution through CTO allocation in Step 2"
<table>
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<tr><td>ER APP ATC 120</td><td>Enhance Conflict Detection and Resolution to Use The RBT/RMT in Step 2</td></tr>
<tr><td>ER APP ATC 147</td><td>Develop conflict resolution functionalities</td></tr>
</table></td><td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
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<tr><th></th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td><table><tr><td>ER APP ATC 150</td><td>New CPDLC messages in support of step2 trajectory management requirements (e.g. TC-SA).</td></tr></table>.</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CM-0607 "Separation Management in En Route using RBTs with 2D RNP Specifications"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-31b</td><td>Exchange of clearances or instructions in step 2</td></tr><tr><td>A/C-34</td><td>On-board management of Precision Trajectory Clearances</td></tr><tr><td>CTE-C02b</td><td>A/G Datalink over ATN/OSI - Single frequency</td></tr><tr><td>CTE-C02c</td><td>A/G Datalink over ATN/OSI - Multi frequency</td></tr><tr><td>CTE-C02e</td><td>New A/G datalink using ATN/IPS over L-band</td></tr><tr><td>CTE-C02f</td><td>Future Satcom for ATM; ESA, IRIS (and SBB)</td></tr><tr><td>ER APP ATC 103</td><td>Enhance Monitoring Aids to Use RBT/RMT Constraints and Commitments in Step 2</td></tr><tr><td>ER APP ATC 125</td><td>Management and Delivery of 2D RNP Clearances for Step 2</td></tr></table>.</td><td>NA</td><td>V1</td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>CM-0208-B "Automated Ground Based Flight Conformance and Intent Monitoring in the TMA"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>ER APP ATC 103</td><td>Enhance Monitoring Aids to Use RBT/RMT Constraints and Commitments in Step 2</td></tr></table>.</td><td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td></tr>
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<p>CM-0408 "Enhanced Conflict Detection and Resolution in the TMA"</p>
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<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>ER APP ATC 120</td><td>Enhance Conflict Detection and Resolution to Use The RBT/RMT in Step 2</td></tr>
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<p>CM-0608 "Separation Management in the TMA using RBTs with 2D RNP Specifications"</p>
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<td>NA</td>
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<td>V1</td>
<td>V2</td>
<td>V3</td>
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<u>Identification of CNS related needs</u>

- New A/G link to support the provision of the ADS-C EPP service, CPDLC and CTA/CTO exchange
- Provision of accuracy monitoring for 2D RNP procedures

Identification of MET/AIM related needs

- Meteorological Nowcast service for wind data based on Mode S reporting
- Meteorological data service for the identification of “No fly” zones

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- MET information integrated in SWIM.

SESAR Solution PJ.10-04: Ad Hoc Delegation of Separation to Flight Deck

Solution Description:

This SESAR Solution consists of In-Trail Follow (ITF) and In-Trail Merge (ITM) Procedures for use En-route in an oceanic environment. ITF procedure allows climbs and descents with reduced longitudinal separation minima while ITM enables horizontal merging with reduced procedural separation minima. A limited transfer of separation responsibility between the controllers and aircrews is assumed (i.e. the duration of the ITF/ITM manoeuvres). In the case of ITF, the separation reduction can continue after having reached the target level. The flight crew has to monitor and maintain separation to a reference aircraft during the manoeuvre until ATCO recovers the responsibility of the separation. The solution should also consider the ongoing work done in the frame of the EUROCAE/RTCA WG51/SC186 standardisation group on PTM (Pair-wise Trajectory Management) that deals with separation in oceanic airspace (ITF and ITM being a subset of procedures addressed in PTM).

This SESAR Solution aims at using primarily ADS-B reports received from surrounding traffic and data from on board sensors and providing the flight crew with information and flight guidance needed to execute the procedure for definition of applicable separation minima.

The solution targets several types of benefits:

- improved flight efficiency as the reduced longitudinal separation minima will allow more frequent vertical adjustments of the flight profile with respect to the current situation. In addition, more flexibility in rerouting may allow airspace users to ask for a change of oceanic exit point according the updated situation and preferences;
- increase flexibility for ATC to reduce complexity of traffic before transition to radar airspace (e.g., rerouting to an alternative exit point using ITM, or creating a train of aircraft following similar routes in the radar airspace, with anticipated radar spacing); and
- increased capacity on the oceanic routes.

Operating Environment:

En-Route Oceanic Environment.

List of OI steps and enablers:

SESAR Solution PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
CM-0701 "Ad Hoc Delegation of Separation to Flight Deck - In Trail Follow & In trail Merge Procedure (ASEP-ITF & ITM)"	V1		V2		V3

Enabler Code	Enabler Title
A/C-16a	Flight management and guidance to support ASEP-ITF/ITM
A/C-31c	Exchange of clearances or instructions in step 3
A/C-48b	Air broadcast of aircraft data (ADS-B OUT) compliant with new DO260C standard
A/C-68	Onboard Traffic situation processing and display for ASAS separation applications, including reception (ADS-B in)
PRO-129	ATC Procedures for assessing, approving and monitoring ASAS Cooperative Separation Applications
PRO-130	ATC Procedures to assess the validity and safety of the proposed transfer of responsibilities
PRO-131	ATC Procedures for recovery of responsibility and re-establishment of safe separation minima if required

Identification of CNS related needs

- None.

Identification of MET/AIM related needs

- In order to maximize the benefits in terms of flight efficiency, the knowledge of wind information at different flight levels will be needed, in particular when there is some traffic flying at that flight level.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

SESAR Solution PJ.10-05: IFR RPAS Integration

Airspace where IFR services are provided can be extremely complex, and there are many challenges surrounding the integration of RPAS into these environments. Research needs to be conducted to investigate ways in which RPAS may be able to use a technical capability or procedural means to comply with ATC instructions.

The other solutions in PJ.10 will also be investigated here from an RPAS perspective, allowing current and new concepts to be researched together.

Specific research needs to determine the impact of integration of RPAS on ATM in some areas presuming RPAS may not be able to comply with all existing manned operations rules, especially in case of control & command data-link loss between RPAS and the remote pilot, or some emergency cases.

Research activities include:

- flight preparation, requiring information management for flight planning, where all intended flight-trajectories are planned in a manner compatible with the ATM Network;
- assessment of whether RPAS might, in the early phases of ATM integration, not behave exactly

the same as other aircraft, because of the latency and a different flight awareness of the crew, and the consequent impact of these factors on separation provision;

- understanding of RPAS-specific trajectories that are not easy to describe in the existing B/MT format - RPAS might also stay on station in a given area that can be across several airspaces boundaries for a very long time, compared to manned aviation, when loitering on a mission for example;
- understanding the sensitivity of RPAS to severe weather conditions and their ability to anticipate them; this might require specific coordination between ATC and the remote pilot especially for reactive manoeuvres, level changes and rerouting;
- ATC will need awareness of RPAS activities in their AOR (Areas of Responsibility). Activities must be pre-announced and the flight plan will need to indicate the fact that the flight is an RPAS. During flight, the air traffic controller and the other airspace users shall have some indication that the aircraft in question is unmanned. ATC shall have knowledge of the contingency procedures;
- for RPAS to be able to fly VFR in managed IFR airspace where VFR flight is permitted, the RPAS will need to be able to meet the obligations of VFR flight, including ‘traffic avoidance’, maintaining VMC conditions and terrain avoidance; and
- analysis of the effects of loss-of-C2 link procedures, which will be developed for RPAS contingencies conditions

Finally, it is important to understand and determine whether RPAS fit into the current manned aircraft classification criteria, or whether there is a need to establish a specific RPAS operation classification.

SESAR Solution PJ.10-05

IFR RPAS Integration

Maturity				
SESAR 1	SESAR 2020			
Maturity Level at the end of SESAR 1	Wave 1			Wave 2
	R6	R7	R8	
	V1		V2	V3

Enabler Code	Enabler Title
EN1	Research activities
EN2	Flight information management
EN3	Awareness for the ATC

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NOTE : in the frame of DS15, an OI for this SESAR solution should be created.

SESAR Solution PJ.10-06: Generic' (non-geographical) Controller Validations

Solution Description:

The current operation generally expects that Controllers hold both a licence for a particular “discipline” (e.g. Area Control, Aerodrome Control etc.) and then a number of sector “validations” which permit that person to exercise their license in defined volumes of airspace. There are several disadvantages to this approach from an operations room efficiency (and, therefore, cost of service) point of view:

- operation “Watch” staff numbers – in order to ensure coverage of all the Centre’s sectors at the likely traffic levels (taking account of seasonable variations) a Watch must have significant over-bearing to cover holidays, sick-leave, maternity-leave and other non-operational demand;

- rostering – sector-based validations leads to significant complexity in managing the rosters to ensure the sectors are suitably manned while respecting the various local and general working time restrictions;
- flexibility – it is difficult to introduce concepts that are based on the flexible movement of sector boundaries if Controller validity is based on particular geographic definitions; and
- airspace change – for even small re-sectorisation the training to convert Controllers from the old to the new is logistically challenging and very costly.

It is expected that the advanced tools and concepts being developed within the PJ.10 Solutions and related projects help to remove some of the requirement for the Controller to be valid on a defined volume of airspace. This Solution will build on those to identify the human, system and procedural needs that might allow a more flexible ATCO validation regime, for example "sector-type validations" (e.g. High-level, TMA…) that would allow a Controller to operate in any airspace classified as a particular type. The Solution will define what additional aids (information, support in emergencies, fall-back modes of operation, etc.) are needed in addition to the pure sector and separation management ones to allow a safe operation with more flexibility of Controller deployment. It is possible that this Solution, and the others which this supports such as flexible airspace boundaries, offers quite considerable operational efficiency gains (and, therefore, cost benefits to the Customers).

Operating Environment:

En-Route and TMA Environments (it will be part of the work of the Solution to determine what level of traffic density and complexity can be catered for). The operational environment is suited to support scheduled, non-scheduled, general aviation and training flights.

List of OI steps and enablers:

SESAR Solution PJ.10-06 Generic' (non-geographical) Controller Validations	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
SDM-0203 "Generic' (non-geographical) Controller Validations"		V1		V2	V3

Identification of CNS related needs

- Not applicable.

Identification of MET/AIM related needs

- Not applicable.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Not applicable.

Performance Goals

The main performance goals for this project include:

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

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.10-01a **High Productivity Controller Team Organisation**	**M**	**M**	**--**	**M**	**--**	**H**	**--**	**--**	**--**	**--**	**--**	**H**
SOLUTION PJ.10-01b **Flight Centric ATC**	**H**	**M**	**M**	**H**	**L**	**M**	**--**	**--**	**M**	**--**	**M**	**H**
SOLUTION PJ.10-01c **Collaborative Control**	**M**	**M**	**L**	**M**	**L**	**H**	**--**	**--**	**--**	**--**	**--**	**H**
SOLUTION PJ.10-02A **Improved Performance in the Provision of Separation**	**H**	**L**	**L**	**--**	**H**	**M**	**--**	**--**	**L**	**--**	**L**	**M**
SOLUTION PJ.10-02B **Advanced Separation Management**	**H**	**M**	**M**	**--**	**H**	**H**	**--**	**--**	**L**	**--**	**M**	**M**
SOLUTION PJ.10-04 **Ad Hoc Delegation of Separation to Flight Deck**	**L**	**M**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**H**	**--**
SOLUTION PJ.10-05 **IFR RPAS Integration**	**--**	**--**	**--**	**--**	**L**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
SOLUTION PJ.10-06 **Generic' (non-geographical) Controller Validations**	**--**	**--**	**--**	**--**	**L**	**L**	**--**	**--**	**--**	**--**	**--**	**M**

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.10-01a **High Productivity Controller Team Organisation**	**L**	The concepts developed in PJ.10-01a are primarily intended to be applied within a Unit (so at ANSP / sub-ANSP level) and really are based upon the capabilities of the local FDP and/or Centre architecture to allow the allocation of a single planner role to several executive ones. It is not expected that these teams would extend across a Centre boundary, so there are no particular IOP requirements introduced by these concepts (above any already identified in the tools that will be used).
SOLUTION PJ.10-01b **Flight Centric ATC**	**N**	Most benefits will be taken if sector-less area is as big as possible, high number of stakeholders involved
SOLUTION PJ.10-01c **Collaborative Control**	**N**	Initially, the application of co-ordination-free transfer of control is likely to be deployed within a Centre (i.e. at the ANSP / sub-ANSP level) in which case the Solution is Local. However, it may be possible at a later juncture to consider broadening the concept to encompass what are currently OLDI boundaries and enhancing the flight object to allow a similar option of co-ordination-free transfer at an Inter-Centre level.
SOLUTION PJ.10-02A **Improved Performance in the Provision of Separation**	**N**	The provision of separation between aircraft shall take into account demand and capacity balancing and traffic synchronization needs on a network level. The introduction of a free route airspace structure will even increase the importance of considering the network level. Although, in general, the tools for TMA support will be ANSP / Centre based, there will be the need to consider demand and capacity balancing needs for both arrivals and departures and, for inbound traffic, to co-ordinate the arrival procedure that may begin across a boundary from the destination TMA
SOLUTION PJ.10-02B **Advanced Separation Management**	**N**	The provision of separation between aircraft shall take into account demand and capacity balancing and traffic synchronization needs on a network level. The introduction of a free route airspace structure will even increase the importance of considering the network level. Although, in general, the tools for TMA support will be ANSP / Centre based, there will be the need to consider demand and capacity balancing needs for both arrivals and departures and,

		for inbound traffic, to co-ordinate the arrival procedure that may begin across a boundary from the destination TMA
SOLUTION PJ.10-04 **Ad Hoc Delegation of Separation to Flight Deck**	**L/N**	Temporarily delegation to flight deck does not involve network actors. Flow control for oceanic airspace may be affected if reduced separation minima can be applied.
SOLUTION PJ.10-05 **IFR RPAS Integration**	**N**	RPAS will need to integrate and consequently all CNS, A-G and G-G issues will need to be re-assessed for unmanned flight
SOLUTION PJ.10-06 **Generic' (non-geographical) Controller Validations**	--	Not applicable

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.10-01a High Productivity Controller Team Organisation

- SESAR 1 P04.07.08 D45 Step 1 V3 Final OSED (Extended ATC Planner)
- SESAR 1 P04.07.08 D47 Step 1 V3 Step 1 V3 Final SPRs (Extended ATC Planner)
- SESAR 1 P04.07.08 DXX Step 1 V2 Initial OSED (Collaborative Control)
- SESAR 1 P04.07.08 DXX Step 1 V2 Initial SPRs (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 D04 Step 1 V2 Final OSED (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 D05 Step 1 V2 Final SPRs (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 DXX Step 1 V2 Final SPRs (Collaborative Control)

Solution PJ.10-01b Flight Centric ATC

- Flight Centric ATC is not covered by SESAR 1, V1 validation for low complexity En-route environment was performed outside SESAR. Concept of operations and validation results are available from:
    - Bettina Birkmeier (2015, publication pending) Operational Feasibility of Sectorless and Partially-Automated Air Traffic Management. (PhD Thesis), DLR/TU-Braunschweig.
    - Biella, Marcus und Birkmeier, Bettina und Korn, Bernd und Edinger, Christiane und Tittel, Sebastian und Kügler, Dirk (2011) Operational Feasibility of Sectorless ATM. CEAS 2011 - The International Conference of the European Aerospace Societies, 24.-28. Oct. 2011, Venice, Italy

Solution PJ.10-01c Collaborative Control

- SESAR 1 P04.07.08 D45 Step 1 V3 Final OSED (Extended ATC Planner)
- SESAR 1 P04.07.08 D47 Step 1 V3 Step 1 V3 Final SPRs (Extended ATC Planner)
- SESAR 1 P04.07.08 DXX Step 1 V2 Initial OSED (Collaborative Control)
- SESAR 1 P04.07.08 DXX Step 1 V2 Initial SPRs (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 D04 Step 1 V2 Final OSED (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 D05 Step 1 V2 Final SPRs (Co-ordinated Boundaries)
- SESAR 1 P05.07.03 DXX Step 1 V2 Final SPRs (Collaborative Control)

Solution PJ.10-02a Improved performance in the provision of separation

- SESAR 1 P04.07.02 D28 OSED_4

- SESAR 1 P04.07.02 D23 Final Safety and Performance Requirements_4
- SESAR 1 P04.07.03 D06 Consolidated Validation Report & Updated OSED
- SESAR 1 P10.04.01 D78 Conflict Detection and Resolution Tools System Requirements Refinement-R5
- SESAR 1 P10.04.02 D44 Consolidated conformance monitoring system requirements
- SESAR 1 P04.07.02 D38 Free Routing Operational Service and Environment Definition (OSED) for Step 1 - Iteration 3
- SESAR 1 P05.07.02 D77 Preliminary V2 OSED for Step 1
- SESAR 1 P05.07.02 D78 Preliminary V2 SPR for Step 1
- SESAR 1 P05.07.02 D79 Preliminary V2 INTEROP for Step 1
- SESAR 1 P05.07.02 D75 MD MC Multi Airport TMA-V2b Validation Report VP738-VP741
- SESAR 1 P05.07.02 D76 HD HC Multi Airport TMA-V2b Validation Report VP740-VP743

Solution PJ.10-02b Advanced Separation Management

- SESAR 1 P04.07.02 D28 OSED_4
- SESAR 1 P04.07.02 D23 Final Safety and Performance Requirements_4
- SESAR 1 P04.07.03 D06 Consolidated Validation Report & Updated OSED
- SESAR 1 P10.04.01 D78 Conflict Detection and Resolution Tools System Requirements Refinement- R5
- SESAR 1 P10.04.02 D44 Consolidated conformance monitoring system requirements
- SESAR 1 P04.07.02 D38 Free Routing Operational Service and Environment Definition (OSED) for Step 1 - Iteration 3
- SESAR 1 P05.07.02 D77 Preliminary V2 OSED for Step 1
- SESAR 1 P05.07.02 D78 Preliminary V2 SPR for Step 1
- SESAR 1 P05.07.02 D79 Preliminary V2 INTEROP for Step 1

Solution PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck

- SESAR 1 P04.07.04b D02 OSED for ASEP Functions v 0.1
- Work of SAE G-10WV wake vortex committee
- EUROCAE/RTCA WG51/SC186 standardisation group

Solution PJ.10-05 IFR RPAS Integration

- A close cooperation of RPAS end users, ANSPs, RPAS manufactures, avionics manufactures and current airspace users is required here. A typical set of expertise required:
- ATC and ATM specialists – from ATCO performing the actual control of air traffic to procedure designers and other stakeholders.
- Operations – pilots (all kinds of operations) and manned aircraft operators.
- RPAS end users – pilots, payload operators.
- Experts in automation in ATM.
- Experts in RPAS performance.
- Safety Assessment Analysis.
- Airspace design.
- Organisations interfaces: ICAO, ACI, EASA, EDA, ANSP, EUROCAE, RPAS operators, RPAS Manufacturers

Solution PJ.10-06 Generic' (non-geographical) Controller Validations

- None.

Dependencies

Dependencies with Other SESAR Solution Projects

The project will closely collaborate with PJ14 CNS Project in order to:

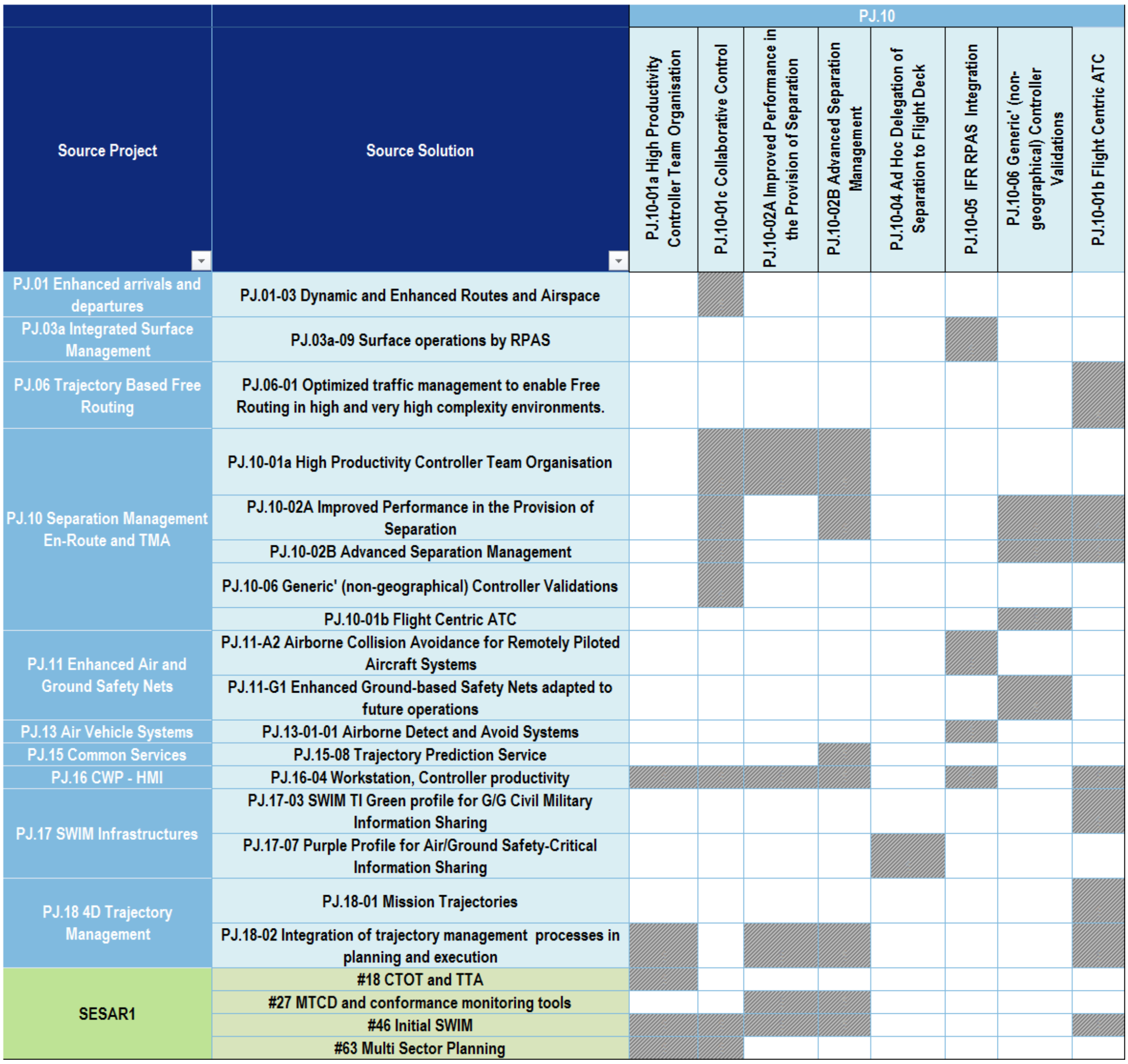
- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.



		PJ.10							
Source Project	Source Solution	PJ.10-01a High Productivity Controller Team Organisation	PJ.10-01c Collaborative Control	PJ.10-02A Improved Performance in the Provision of Separation	PJ.10-02B Advanced Separation Management	PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck	PJ.10-05 IFR RPAS Integration	PJ.10-06 Generic' (non-geographical) Controller Validations	PJ.10-01b Flight Centric ATC
PJ.01 Enhanced arrivals and departures	PJ.01-03 Dynamic and Enhanced Routes and Airspace		▨						
PJ.03a Integrated Surface Management	PJ.03a-09 Surface operations by RPAS						▨		
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.								▨
PJ.10 Separation Management En-Route and TMA	PJ.10-01a High Productivity Controller Team Organisation		▨	▨	▨				
	PJ.10-02A Improved Performance in the Provision of Separation		▨		▨			▨	▨
	PJ.10-02B Advanced Separation Management		▨					▨	▨
	PJ.10-06 Generic' (non-geographical) Controller Validations		▨						
	PJ.10-01b Flight Centric ATC							▨	
PJ.11 Enhanced Air and Ground Safety Nets	PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems						▨		
	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations							▨	
PJ.13 Air Vehicle Systems	PJ.13-01-01 Airborne Detect and Avoid Systems						▨		
PJ.15 Common Services	PJ.15-08 Trajectory Prediction Service				▨				
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity	▨	▨	▨	▨		▨		▨
PJ.17 SWIM Infrastructures	PJ.17-03 SWIM TI Green profile for G/G Civil Military Information Sharing								▨
	PJ.17-07 Purple Profile for Air/Ground Safety-Critical Information Sharing					▨			
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories								▨
	PJ.18-02 Integration of trajectory management processes in planning and execution	▨		▨	▨				▨
SESAR1	#18 CTOT and TTA	▨							
	#27 MTCD and conformance monitoring tools			▨	▨				
	#46 Initial SWIM	▨	▨	▨	▨				▨
	#63 Multi Sector Planning	▨	▨						

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

Source Project	Source Solution	PJ.01	PJ.08		PJ.09			PJ.10					PJ.11	PJ.13	PJ.14					PJ.15		PJ.16		PJ.17	PJ.18	
		PJ.01-03 Dynamic and Enhanced Routes and Airspace	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	PJ.09-01 Network Prediction and Performance	PJ.09-02 Integrated Local DCB Processes	PJ.09-03 Collaborative Network Management Functions	PJ.10-01c Collaborative Control	PJ.10-02A Improved Performance in the Provision of Separation	PJ.10-02B Advanced Separation Management	PJ.10-06 Generic' (non-geographical) Controller Validations	PJ.10-01b Flight Centric ATC	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations	PJ.13-01-01 Airborne Detect and Avoid Systems	PJ.14-01-01 CNS environment evolution	PJ.14-02-01 FCI Terrestrial Data Link	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	PJ.14-04-01 Surveillance Performance Monitoring	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	PJ.15-08 Trajectory Prediction Service	PJ.15-09 Virtual Centre Service	PJ.16-04 Workstation, Controller productivity	PJ.16-03 Virtual Centre concept	PJ.17-03 SWIM TI Green profile for G/G Civil Military Information Sharing	PJ.18-01 Mission Trajectories	PJ.18-02 Integration of trajectory management processes in planning and execution
PJ.10 Separation Management En-Route and TMA	PJ.10-01a High Productivity Controller Team Organisation							▨	▨	▨												▨	▨			▨
	PJ.10-01b Flight Centric ATC				▨	▨	▨				▨		▨			▨					▨	▨	▨	▨	▨	▨
	PJ.10-01c Collaborative Control		▨																			▨	▨			
	PJ.10-02A Improved Performance in the Provision of Separation	▨	▨	▨				▨		▨	▨	▨			▨	▨	▨			▨		▨	▨			▨
	PJ.10-02B Advanced Separation Management	▨	▨	▨				▨			▨	▨			▨	▨	▨					▨	▨			▨
	PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck															▨		▨	▨							
	PJ.10-05 IFR RPAS Integration													▨								▨				
	PJ.10-06 Generic' (non-geographical) Controller Validations							▨																		

Dependencies with External Activities

- ICAO expert Panels dealing with separation applications and respective CNS enablers (e.g. SASP, OPLINKP, ACP)
- Co-ordination with EUROCAE/RTCA WG51/SC186

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

- Update of EUROCAE/RTCA WG51/SC186 standardisation work
- Update of ICAO PANS-ATM for Separation Application
- Update of ICAO Annex 11 for Separation Application

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
  - SESAR ConOps,
  - ATM Operational Concept (En Route),
  - ATM Operational Experience (En Route),
  - ATC users requirements (ground & air),
  - Airspace users and airlines operators requirements including GA / Rotorcraft / RPAS,
  - Pilot/aircraft capabilities and constraints,
  - Military specific needs,
  - Validation methodologies,
- System:
  - System engineering, prototyping,
  - System development,

  - System Architecture, SOA,
  - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
  - Aircraft and avionics;
  - Datalink / data communication,
  - Ergonomics, Human-machine Interface (HMI)
  - Information management,
  - Verification methodologies,
- Management and coordination:
  - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
  - Project management,
  - Quality management.
- Performance and Transversal Areas Assessments
  - Safety, security and environment performance measurement,
  - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
  - Technical expertise, knowledge and capabilities related to the European network as a whole,
  - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.12 Advanced Air Traffic Services – Enhanced Air & Ground Safety Nets (PJ11)

PJ.11	**Enhanced Air and Ground Safety Nets**

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 Release 1 with the SESAR Solution named "Enhanced Short Term Conflict Alert (STCA) for Terminal Manoeuvring Areas (TMAs) ».
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 in Release 3 with the SESAR Solution named "Enhanced STCA with down-linked parameters ».
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 in Release 1 with the use of Autoflight systems for enhanced compliance with TCAS II RAs (compliant with TCAS II Version 7).
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 Release 1 with the use of Autoflight systems for enhanced compliance with TCAS II RAs (compliant with TCAS II Version 7).
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 in Release 1 with the use of Autoflight systems for enhanced compliance with TCAS II RAs (compliant with TCAS II Version 7). 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 deserves to be further investigated.

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

1) 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 improvement of ground-based safety nets using downlinked aircraft parameters (DAPs) has achieved end of V3 only for the STCA.

   Within SESAR 1, the adaptation of ground-based 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.

2) 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 and to new categories of airspace users has not been studied.

   There is a need to anticipate the required evolution of ACAS for the future operations in Europe and take into consideration potential adaptations required in the European context. The current strategy is to contribute to ACAS X development and standardisation. ACAS X is a set of FAA collision avoidance systems currently under development: ACAS Xa for normal operations of Commercial Air Transport (CAT), ACAS Xo for specific operations of CAT, ACAS Xu for RPAS operations and ACAS Xp for GA/RC operations. A priority issue is the analysis of the ACAS X systems operational and pilot acceptability.

3) 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 interaction of ground-based safety nets and airborne safety nets has not been studied.

Overall, failure to adapt the safety nets to the changing environments developed by SESAR will have two consequences:

- Their lack of improved capacity to timely identify hazardous situations (and provide advice when applicable) will not allow to achieve the SESAR safety target as the number of hazardous situations will increase with the traffic;

- Their lack of knowledge of the new traffic patterns and of operations with reduced spacing will trigger undesired alerts, which will have a negative effect on the safety net users' efficiency and may reduce the safety net users confidence in their relevance, possibly reducing the safety benefit otherwise brought about by the safety net.

An essential asset in the study of the improvement of safety nets is the use of validation platforms allowing fast-time simulations of the relevant safety nets on situations representative of the European airspace, with the capacity to focus on targeted operations, as the events that trigger safety nets are difficult to reproduce in real time in sufficient numbers and with complete realism.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

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), while minimising negative operational interactions between ACAS and STCA;

  This will be explored by solution PJ.11-G1.
- 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;

  This will be done by solutions PJ.11-A1, PJ.11-A2, PJ.11-A4 (Enhanced ACAS for Commercial Air Transport normal operations, ACAS for RPAS and ACAS for GA) and solution PJ11.A3 for (Enhanced ACAS for Commercial Air Transport specific operations).
- Provide inputs and influence the work on Ground / Airborne Safety Nets at global and regional standardisation level, within ICAO (in coordination with FAA for ACAS), EUROCAE and RTCA.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.11-G1: Enhanced ground-based safety nets adapted to future operations

Solution Description:

This SESAR Solution aims at:

- ensuring that the ground-based safety nets continue to work with the future operations introduced by other SESAR solutions

  Future operations may modify the traffic patterns, the trajectory characteristics, the airspace design and the separation minima. So, there is a need to check that ground-based safety nets maintain their performance in the new circumstances, and if necessary introduce the use of new data modify some alerting thresholds, modify rules of aircraft eligibility or define new areas of specific behaviour.

  This is particularly the case for new separation modes where lower separation minima are considered. In part as a result of the introduction of the delegation of the role of separator, aircraft may fly in close proximity to each other with geometries that would trigger STCA as we know it to-day unless the system is made capable of recognising situations where such new separation modes are being applied. These new separation modes include ASAS applications such as ASEP-ITF and ASEP-ITM (developed by PJ10) but may include other solutions developed by PJ10 and PJ01.

  As the future operations will be developed as part of SESAR 2020 programme, impacts on STCA may be identified during the course of the project; it will be then needed to check whether this requires modifications to the STCA concept or not.

- improving the compatibility between STCA and ACAS

  The performance of STCA depends on the relevance and timeliness of not only the alerts of the technical system itself but also of the reaction of the controller. Within complex environment (e.g. dense TMA with very close traffic patterns), STCA parameter setting strategies aim at preventing mid-air collisions through limited separation protection in order to keep the number of nuisance alerts to an acceptable minimum, but results in late STCA alerts with increased likelihood of interaction with ACAS RAs.

  There are also encounter situations (like sudden aircraft convergence on specific traffic patterns or sudden climb/descent towards an occupied flight level) for which both STCA alert and ACAS RA can be triggered close to each other (whatever the level of separation protection targeted by STCA). These situations and strategies increase the risk for the controller's avoiding instructions prompted by STCA to compete with ACAS RAs, particularly when these instructions are modifying the vertical trajectory of the aircraft (because ACAS RAs also act on vertical trajectory).

The safety nets need to be complementary instead of sometimes 'competing' (rendering each other less effective or even contributing factors in incidents/accidents). The aim is to ensure that in accordance with the predefined rules and the prevailing circumstances the pilot, the controller or both get a warning and resolution advisory in a way which preserves their common situational awareness and avoids interactions degrading safety.

The following outputs are expected:

- Development of minimum Safety and Performance requirements for the STCA
- Development of guidance material recommending best practices for STCA optimisation to reach an acceptable level of interaction with ACAS in the European airspace
- Procedural modifications for short-term conflict management (including ATCO avoiding instructions in response to STCA alerts), taking into account human performance aspects
- Use by STCA of supplementary information, while preserving the independence of both systems: for example, it is not planned to use the information that there is a TA or an RA on-board an aircraft to change the triggering of the STCA.

The project will have to identify the new interactions between safety nets that could occur due to future operations, amend the safety nets operational concept as well as requirements accordingly and check that these changes work in the relevant operations.

These two objectives should be progressed together as they are closely linked. It is expected for both of them to take advantage of the availability of new or more accurate trajectory and airspace data. This set of data can be obtained through means with different timescales of availability: Mode S Enhanced Surveillance, ADS-B, ADS-C (EPP) and SWIM services. Downlinked information from the aircraft can provide better trajectory data (both current and intended) while SWIM can provide up to date knowledge of airspace configuration.

The studies conducted under SESAR1 (stopped in V2, both for most uses of Mode S DAPs and for the use of other surveillance / SWIM data) concluded that the most promising options for STCA consist in using trajectory data to improve trajectory prediction, to provide Resolution Advisories to air traffic controllers and to determine safety net parameters for alert generation. In addition, the use of FMS levels should be considered for use in STCA.

The project will have to refine the expected benefits from these options based on traffic samples representing relevant operations and fully develop the concepts (and associated systems and interfaces) for which the benefits and feasibility are confirmed. If necessary, the project will have to contribute to the maintenance and development of the SWIM services required for this Solution.

Ultimately, this SESAR Solution will

- Provide controllers with an alerting system which is robust against information error or missing information.
- Improve the Ground-based safety net performance, e.g. to detect that the separation mode has been compromised and to provide/propose resolution action.

Operating Environment: TMA and En Route. Free Route environment with High & Very High complexity.

RPAS and GA/RC can benefit from this solution if their equipment allows the transmission of the required data.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.11-G1
Enhanced Ground-based Safety Nets adapted to future operations</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>
CM-0807-B "Enhanced Ground-based Safety Nets Using Wide Information Sharing"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>ER APP ATC 137</td><td>Upgrade Ground Safety Nets to use SWIM available additional information</td></tr>
<tr><td>PRO-135</td><td>ATC Procedures for validating and reacting to safety net warnings and modifying a/c trajectories in response</td></tr>
</table>
CM-0806-B "Improved Compatibility between STCA and ACAS in a Step 2 environment"
CM-0805 "Short Term Conflict Alert Adapted to New Separation Modes"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 69</td><td>STCA Separation Parameters Defined for Various Types of Aircraft and Operations</td></tr>
<tr><td>PRO-174</td><td>ATC Procedures for responding to alerts when aircraft is responsible for separation</td></tr>
</table>
CM-0806-C "Improved Compatibility between Ground and Airborne Safety Nets in a Step 3 environment"
</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
</table>

Identification of CNS related needs

- Mode S, ADS-B or ADS-C (EPP capability)

Identification of MET/AIM related needs

- Airspace status information

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Because STCA may apply different alert eligibility and parameters depending on the area of the airspace in which aircraft are located the two following services may be needed:
    - ARESActivationService
    - ARESDeactivationService

  (It is assumed here that the ARES related services also provide the AIM data expressed above. If not, the relevant services should be added to the above list)
- The possible use of RBT/RMT in ground-based safety nets, and modifications to them due to avoiding manoeuvres calls for the use of the following services:
    - SharedFlightObject
    - ATCFlightObjectControl

SESAR Solution PJ.11-A1: Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations - ACAS Xa.

Solution Description:

Improving on current Airborne Collision Avoidance for Commercial Air Traffic by taking advantage of optimized resolution advisories and of additional surveillance data, without changing the cockpit interface (same alerts and presentation). Indeed, the performance of collision avoidance can be improved by:

- Using information from the more accurate surveillance source available. Currently collision avoidance alerts are based on a unique source (active Mode C/S interrogations). This is expected to improve marginally both safety and operational compatibility;
- Optimizing the rules for triggering an RA by applying state-of-the-art mathematical processes and modelling. Currently collision avoidance alerts are based on a series of empirical rules. This is expected to improve significantly both safety and operational compatibility.

This SESAR Solution refers to ACAS Xa that is the variant of the ACAS X concept for Commercial Air Transport normal operations. ACAS X is an FAA currently-under-development new family of collision avoidance systems. ACAS Xa is an aircraft collision avoidance system being designed with the intention to be proposed as the next generation of TCAS II system with general equipage beginning in the 2020-2023 timeframe. ACAS Xa implements the two improvements described above, with ADS-B surveillance as the additional surveillance source.

Since 2010, the FAA has developed successive versions of ACAS Xa in order to converge to a near-final version that will be used for the MOPS development. In parallel, the standardization of the system in a joint RTCA / EUROCAE group; this group actively participates to the development and validation of ACAS Xa, with a goal to publish the first ACAS Xa standards in 2018.

It is then important to ensure that European safety & performance requirements are taken into account during the design and development of ACAS Xa to prevent issues. This is particularly valid with the versions named RUN 15 and RUN 16 that will be the ones used for the MOPS development.

In that context, the project has to provide RTCA/EUROCAE with inputs that allow EUROCAE to influence ACAS Xa design & standardisation. The objective is to achieve full benefits and to ensure safety and operational acceptability in European airspace by integrating European targets & requirements.

Operating Environment: TMA and En Route. Free Route environment with High & Very High complexity.

- Remotely Piloted Air Systems (RPAS) are addressed by SESAR Solution PJ.11-A2, with the validation of the ACAS Xu variant of ACAS X.
- GA/RC are addressed by SESAR Solution PJ.11-A4, with the validation of the ACAS Xp variant of ACAS X.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.11-A1 Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations - ACAS Xa</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0808-a "Enhanced Airborne Collision Avoidance adapted to Trajectory based operations"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-54a</td><td>Enhanced Airborne Collision Avoidance (ACAS)</td></tr></table>.</td><td>V2</td><td></td><td></td><td>V3</td><td></td></tr>
</table>

NOTE : the CM-0808 should be split in CM-0808-a, CM-0808-u, CM-0808-p in the frame of DS15.

Identification of CNS related needs

- ADS-B equipage.

Identification of MET/AIM related needs

- None.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

SESAR Solution PJ.11-A2: Airborne Collision Avoidance for Remotely Piloted Aircraft Systems – ACAS Xu

Solution Description:

Providing Airborne Collision Avoidance to RPAS using the two features described in PJ11-A1 (different surveillance sources and state-of-the-art optimisation of RAs), but taking into account the operational specificities of the RPAS. The additional surveillance sources could be ADS-B but also any other sensor installed on the RPAS (electro-optical, IR…). The RAs strength and direction could be adapted to the capabilities of the RPAS. For example, horizontal RAs could be introduced for RPAS unable of reaching the vertical acceleration/speeds required for vertical RAs.

This SESAR Solution refers to ACAS Xu that is the variant for RPAS of the ACAS X concept. ACAS X is an FAA currently-under-development new family of collision avoidance systems. ACAS Xu has started development in the United States, but is less mature than the CAT variant, ACAS Xa. In coordination with the FAA development team and with PJ.13, the project will have to investigate if ACAS Xu helps the integration of RPAS in the European airspace and to provide elements to improve the ACAS X concept for Europe. The project will research any additional factors affecting collision avoidance with the platform in question being unmanned. This will include, *inter alia*, human factors and system latency.

The project has to provide RTCA/EUROCAE with inputs that allow EUROCAE to influence ACAS Xu design & standardisation. The objective is to achieve full benefits and to ensure safety and operational acceptability in European airspace by integrating European targets & requirements.

Operating Environment: TMA and En Route.

CAT is addressed by SESAR Solutions PJ.11-A1 (normal operations) and PJ.11-A3 (specific operations). GA/RC are addressed by SESAR Solution PJ.11-A4, with the validation of the ACAS Xp variant of ACAS X.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SOLUTION PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems – ACAS Xu</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0808-u "Enhanced Airborne Collision Avoidance adapted to Trajectory based operations"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-54a</td><td>Enhanced Airborne Collision Avoidance (ACAS)</td></tr>
</table>
.</td><td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

NOTE : the CM-0808 should be split in CM-0808-a, CM-0808-u, CM-0808-p in the frame of DS15.

Identification of CNS related needs

- ADS-B.

Identification of MET/AIM related needs

- None.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

SESAR Solution PJ.11-A3: ACAS for Commercial Air Transport specific operations – ACAS Xo

Solution Description:

Improving Airborne Collision Avoidance to CAT using the two features described in PJ11-A1 (different surveillance sources and state-of-the-art optimisation of RAs), while avoiding unnecessary triggering of RAs in new separation modes, in particular if lower separation minima are considered.

In part as a result of the introduction of the delegation of the role of separator, aircraft may fly in close proximity to each other with geometries that would trigger ACAS as we know it today unless the system is made capable of recognising situations where such new separation modes are being applied. These new separation modes include ASAS applications such as ASEP-ITF and ASEP-ITM (developed by PJ10) but may include other solutions developed by PJ.10, PJ06 and PJ01 (for instance related to parallel runway operations). The project will have to identify (as part of V1) the solutions that have an impact on ACAS performance.

This SESAR Solution refers to ACAS Xo that is the variant for CAT specific operations of the ACAS X concept. ACAS X is an FAA currently-under-development new family of collision avoidance systems. ACAS Xo is the complement of ACAS Xa and is being developed alongside it. Aircraft with ACAS Xo will use ACAS Xa when in normal operations. ACAS Xo changes the collision avoidance “rules” protecting from an aircraft selected for a specific application. In the United States, the first applications (of which one is for Closely Spaced Parallel Approaches) will be developed and standardized in the same timeframe as ACAS Xa, i.e. by 2018.

Therefore, there are two aspects for Europe in this activity:

1) In coordination with the FAA ACAS X development team, the project will have to determine European needs & requirements and ensure the development of ACAS Xo applications correctly take into account these needs and the European environment;
2) the project will have to determine if additional Xo applications are needed for Europe, particularly to address new separation modes; this may go together with the production of specific collision avoidance “rules”, if possible with the support of the FAA ACAS X development team. This second aspect may extend beyond 2018, hence the remote positions of V2 and V3 in the maturity table below.

The project has to provide RTCA/EUROCAE with inputs that allow EUROCAE to influence ACAS Xo design & standardisation. The objective is to achieve full benefits and to ensure safety and operational acceptability in European airspace by integrating European targets & requirements.

Operating Environment: TMA and En Route.

This solution does not cover RPAS or GA/RC as ACAS Xo is currently designed for use by CAT only and the specific versions of ACAS X for RPAS (Xu, see PJ.11-A2) and GA/RC (Xp, see PJ.11-A4) do not cater for new separation modes.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.11-A3 ACAS for Commercial Air Transport specific operations – ACAS Xo</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>CM-0804 "ACAS Adapted to New Separation Modes"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-54b</td><td>ACAS adaptation to new separation modes</td></tr></table>.</td><td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

Identification of CNS related needs

- ADS-B.

Identification of MET/AIM related needs

- None.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

SESAR Solution PJ.11-A4: Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp

Solution Description:

The solution aims at providing Airborne Collision Avoidance to GA/RC, taking into account the limited capability of GA to carry equipment and its operational specificities. The idea is that GA/RC aircraft would be capable of responsive coordination: after receiving an ADS-B squitter that identifies them as an intruder in an ongoing RA on-board another aircraft, the GA/RC aircraft would be aware of the RA direction of the other aircraft, and would use it to determine its own manoeuvre with GA/RC-adapted advisories.

This SESAR Solution refers primarily to ACAS Xp that is the variant for RPAS of the ACAS X concept. ACAS X is an FAA currently-under-development new family of collision avoidance systems. ACAS Xp has started development in the United States, but is far less mature than the CAT variant, ACAS Xa. In coordination with the FAA development team and with PJ.13, the project will have to determine European needs & requirements related to ACAS Xp usage in Europe environment including its benefits in the European airspace; when necessary, the project will have to provide elements to improve the concept.

The project has to provide RTCA/EUROCAE with inputs that allow EUROCAE to influence ACAS Xp design & standardisation. The objective is to achieve full benefits and to ensure safety and operational acceptability in European airspace by integrating European targets & requirements.

Another way of implementing responsive coordination would be to enhance the recently standardized Traffic Situation Awareness with Alerts (TSAA) system. The benefits achievable through this enhancement should be investigated as well, together with potential interoperability requirements.

Operating Environment: TMA and En Route.

CAT is addressed by SESAR Solutions PJ.11-A1 (normal operations) and PJ.11-A3 (specific operations).

Remotely Piloted Air Systems (RPAS) are addressed by SESAR Solution PJ.11-A2, with the validation of the ACAS Xu variant of ACAS X.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.11-A4 Airborne Collision Avoidance for General Aviation and Rotorcraft – ACAS Xp</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>CM-0808-p "Enhanced Airborne Collision Avoidance adapted to Trajectory based operations"<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>A/C-54a</td><td>Enhanced Airborne Collision Avoidance (ACAS)</td></tr></table></td><td>NA</td><td>V1</td><td></td><td>V2</td><td>V3</td></tr>
</table>

NOTE : the CM-0808 should be split in CM-0808-a, CM-0808-u, CM-0808-p in the frame of DS15.

Identification of CNS related needs

- ADS-B

Identification of MET/AIM related needs

- None.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None.

Performance Goals

The main goal is to increase safety, reducing the number of ATM related accidents and incidents.

Identification of impacted KPAs & Transversal Areas (Provide any evidence/comments that can justify compliance with the impacts in performance identified below):

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.11-G1 **Enhanced ground-based safety nets adapted to future operations**					M	H						
SOLUTION PJ.11-A1 **Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations – ACAS Xa**					H	H						
SOLUTION PJ.11-A2 **Airborne Collision Avoidance for Remotely Piloted Aircraft Systems- ACAS Xu**					H	M						
SOLUTION PJ.11-A3 **ACAS for Commercial Air Transport specific operations- ACAS Xo**					H	H						
SOLUTION PJ.11-A4 **Airborne Collision Avoidance for GA – ACAS Xp**					H	L						

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.11-G1 **Enhanced ground-based safety nets adapted to future operations**	N	Ground-based safety nets are operated throughout controlled airspace in Europe. STCA and ACAS interactions can occur throughout controlled airspace in Europe.
SOLUTION PJ.11-A1 **Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations**	N	ACAS is constantly operated by CAT in all kinds of airspace throughout Europe.
SOLUTION PJ.11-A2 **Airborne Collision Avoidance for Remotely Piloted Aircraft Systems**	N	Airborne Collision Avoidance is expected to be constantly performed by RPAS in nearly all kinds of airspace, as the objective is a seamless integration of RPAS in European airspace.
SOLUTION PJ.11-A3 **ACAS for Commercial Air Transport specific operations**	N	ACAS is constantly operated by CAT in all kinds of airspace throughout Europe. A specific operation might be associated to one environment, but the whole set of specific operations might cover nearly all environments.
SOLUTION PJ.11-A4 **Airborne Collision Avoidance for GA**	N	Airborne Collision Avoidance is expected to be constantly performed by GA in all airspaces except class A.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

Solution PJ.11-G1 Enhanced ground-based safety nets adapted to future operations

- SESAR 1 P04.08.01 D12 VR-Feasibility-DAP-G-SNET-V2 Feasibility and options for use of DAP in G-SNETs
- SESAR 1 P04.08.01 D18 SPR-DAP-G-SNET-V2 Preliminary SPR for G-SNETs using DAP
- SESAR 1 P04.08.01 D17 OR-DAP-G-SNET-V2 Preliminary OR for the use of DAP in G-SNETs
- SESAR 1 P04.08.01 D14 VR-Benefits-DAP-Other-G-SNET-V2 Evaluation of safety benefits of other G-SNETs using DAP
- SESAR 1 P04.08.01 D16 VR-Costs-DAP-G-SNET-V2 Estimated costs for the use of DAP in G-SNETs.
- SESAR 1 P04.08.01 D29 OSED-TRAJ-G-SNET-V2 Preliminary OR for G-SNETs adapted to 3-4D TRAJ

- SESAR 1 P04.08.01 D98 Final Step 2 Technical Note: Roadmap for European (or Global) Encounter Models
- SESAR 1 P04.08.01 D100 Final Step 2 Technical Note: Input for Global Concept of Operation for Collision Avoidance
- SESAR 1 P10.04.03 D32 Final Technical Specifications for Phase 3 (Safety Nets are adapted to advanced ATM concepts)
- SESAR 1 P04.08.01 D25 VALR-TRAJ-G-SNET-V2 Validation report -V2- for G-SNETs adapted to 3-4D TRAJ
- SESAR 1 P04.07.02 D38- Free Routing Operational Service and Environment Definition (OSED) for Step 1 - Iteration 3
- Initial SWIM related documents

Solution PJ.11-A1 Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations – ACAS Xa

- SESAR 1 P04.08.2 D36 OSED-ACASX-CURRENT Operational and performance requirements for ACAS Xa in Europe
- SESAR 1 P04.08.01 D93 SPR-ACASX-OPT2 Requirements of an optimized ACAS Xa logic for future European operations
- SESAR 1 P04.08.01 D92 VALR-ACASX-OPT1 Validation report for the evaluation of ACAS Xa optimized for Europe
- SESAR 1 P04.08.01 D95 VALR-ACASX-HP Validation report for the assessment of human performance aspects of ACAS Xa
- SESAR 1 P09.47 D29 STM FRD - issue 3

Solution PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems – ACAS Xu

- None

Solution PJ.11-A3 ACAS for Commercial Air Transport specific operations – ACAS Xo

- None

Solution PJ.11-A4 Airborne Collision Avoidance for GA – ACAS Xp

- None

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.11			
Source Project	Source Solution	PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems	PJ.11-A3 ACAS for Commercial Air Transport specific operations	PJ.11-A4 Airborne Collision Avoidance for GA	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations
PJ.10 Separation Management En-Route and TMA	PJ.10-01b Flight Centric ATC				▨
PJ.11 Enhanced Air and Ground Safety Nets	PJ.11-A1 Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations	▨	▨	▨	
PJ.13 Air Vehicle Systems	PJ.13-01-01 Airborne Detect and Avoid Systems	▨			
	PJ.13-02-03 GA/R Specific Surveillance Systems				▨
PJ.15 Common Services	PJ.15-10 Static Aeronautical Data Service				▨
PJ.17 SWIM Infrastructures	PJ.17-07 Purple Profile for Air/Ground Safety-Critical Information Sharing				▨
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories				▨
	PJ.18-02 Integration of trajectory management processes in planning and execution				▨
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)				▨
SESAR1	#46 Initial SWIM				▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.10		PJ.11		
Source Project	Source Solution	PJ.10-05 IFR RPAS Integration	PJ.10-06 Generic' (non-geographical) Controller Validations	PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems	PJ.11-A3 ACAS for Commercial Air Transport specific operations	PJ.11-A4 Airborne Collision Avoidance for GA
PJ.11 Enhanced Air and Ground Safety Nets	PJ.11-A1 Enhanced Airborne Collision Avoidance for Commercial Air Transport normal operations			▨	▨	▨
	PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems	▨				
	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations		▨			

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

Solutions related to ACAS X (PJ.11-A1, PJ.11-A2, PJ.11-A3, PJ.11-A4) need to be progressed in coordination with the FAA under CP4.1 in the context of the RTCA/EUROCAE activities described in more detail below.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is assumed that currently applicable standards and regulations are applicable to the work in this project.

- Standards for airborne collision avoidance systems (ACAS) exist in ICAO Annex 10 to ensure minimum surveillance and collision avoidance performance, as well as communication between ACAS. ACAS procedures are defined in PANS-ATM, Doc 4444 and in PANS-OPS, Doc 8168. Detailed specifications of algorithms for current TCAS (ACAS compliant system) exist in RTCA MOPS (DO-185A and DO-185B) and EUROCAE MOPS (ED-143). Worldwide carriage recommendation is included in ICAO Annex 6. European Implementing Rule 1332/2011 requires ACAS equipment on a range of commercial aircraft. Standards for ACAS hybrid surveillance exist in RTCA MOPS (DO-300, DO300A for extended hybrid surveillance) and EUROCAE MOPS (ED-221).
- No international standards or regulations exist for ground-based safety nets systems. ICAO procedures can be found in PANS-ATM (Doc 4444), section 15.7.2 and 15.7.4. General specifications and guidance have been developed by Eurocontrol for STCA, APW, APM and MSAW. ESSIP provides Lines of Actions related to ground-based safety nets.

Identification of on-going standardization and regulatory activities where the project should contribute to:

- The project shall provide inputs to the EUROCAE WG-75 and RTCA SC-147 (often holding joint meetings) and participate as required in order to influence the standardization of new ACAS developments (for solutions based on ACAS X: PJ.11-A1, PJ.11-A2, PJ.11-A3, and PJ.11-A4) to achieve full benefits and to ensure safety and operational acceptability in European airspace by integrating European targets & requirements.
- The European ACAS mandate may also have to be amended to allow the introduction of the new ACAS (at least for the solution replacing current ACAS, PJ.11-A1). In this perspective, a key player will be EASA, which is aware of the new ACAS developments through its participation in EUROCAE WG-75.
- Standardization and regulation of ground-based safety nets is an open question (for solution PJ.11-G1) but provision should be made by the project to deliver the material that could form the basis for the development of a standard if the requirement is confirmed.
- ICAO Surveillance Panel (SP) is in charge of modifying ACAS documentation and of drafting a manual for ground-based safety nets, so input from the project would be of interest to ASP (for all solutions).

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA),
    - ATM Operational Experience (En Route, TMA),
    - ATC users requirements (ground & air),
    - Airspace users and airlines operators requirements including GA / Rotorcraft / RPAS,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,

  - System development,
  - System Architecture, SOA,
  - ATM tools (ATC, CNS, Flight Operations Centre, Network…),
  - Aircraft and avionics;
  - Datalink / data communication,
  - Ergonomics, Human-machine Interface (HMI)
  - Information management,
  - Verification methodologies,
- Management and coordination:
  - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
  - Project management,
  - Quality management.
- Performance and Transversal Areas Assessments
  - Safety and performance measurement,
  - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
  - Technical expertise, knowledge and capabilities related to the European network as a whole,
  - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- SPR
- INTEROP
- OSED
- TS/IRS
- Cost Benefit Assessment
- Communication Plans and results
- ACAS X performance analysis reports as an input to EUROCAE/RTCA

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.13 Enabling Aviation Infrastructure – Air Vehicle Systems (PJ13)

PJ.13	**Air Vehicle Systems**

Problem Statement

The successful integration of 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, RPAS operations are not routinely integrated into the ATM environment and 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 a national level.

One of the purposes of the present project will be to ensure a cross-fertilisation of technical solutions between RPAS and GA/R and this will be obtained thanks to a technical coordination between the project areas. This project shall focus on technical aspects that are unique to RPAS and GA/R, consistently with the user needs and the operational requirements expressed in other SESAR2020 projects and, for the GA/rotorcraft topic, in accordance with the output of SESAR 1 project 4.10.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

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 cover two main areas: integrated RPAS operations, specifically Airborne Co-operative Detect and Avoid (D&A) and General Aviation and Rotorcraft (GA/R) operations. It must be noted that solutions to be developed might and should be applicable to both areas. This includes:

- Enabling integrated RPAS operations:
    - Airborne Detect and Avoid (D&A) Systems supporting integrated RPAS operations
- Systems to enable Integrated General Aviation and Rotorcraft (GA/R) operations in the European Air Traffic Management System:
    - GA/R Specific Communication Systems
    - GA/R Specific Navigation Systems
    - GA/R Specific Surveillance Systems
    - GA/R Specific Information Management Systems

It is important to take into consideration that RPAS/GA/R terms are generic and do actually integrate a wide range of air vehicles and a wide variety of weight/avionics complexity. As far as GA development is concerned, large airplanes with complex avionics are not considered as part of the scope (covered outside the project e.g. PJ.14).

One of the main first steps of PJ.13 will be to clearly identify the target population of aircraft that are considered by the project solutions, and specifically appropriate 'mission' types, where these have not been identified and studied within other Solution Projects. DOWs from ATM Solution projects already consider GA/R and RPAS as distinct airspace users, and, where necessary, the specific requirements from GA/R and RPAS should be described. Validation plans shall include validation objectives for all AU classes, including GA/R and RPAS.

For each individual solution, the following activities are to be undertaken:

- Analysis of operational requirements

- Feasibility assessment
- Functional analysis
- Technical specifications
- Safety Cases
- Preliminary assessment of likely level of cost against anticipated benefits, where such an analysis is appropriate
- Prototyping of target solutions
- Support to validation
- Support to international standardisation activities

Validation

The present solution will only address technical developments; hence the evaluation of operational aspects will be performed in the operational projects. Since it will be necessary to interact with other projects to deliver a complete solution, this will be taken in consideration when designing the validation activities.

Input documents

- Operational Services and Environment Description (OSED)
- Safety and Performance Requirements (SPR)
- Interoperability requirements (INTEROP)
- Validation Plan (VALP)

Final deliverables

- Feasibility report
- Technical specification
- Cost benefit analysis
- Verification & Validation Report
- Prototypes for supporting the validation activities in the ATM Solution Projects.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

PJ.13-01:Systems enabling integrated RPAS operations in the European Air Traffic Management System

General

The solution described below is taken from the activities identified in the SESAR RPAS Definition Phase Document which, in turn, builds on the European Commission 'Roadmap for the integration of civil RPAS into the European Aviation System'. Both of those documents should be considered as core references for more details on the solution presented here, with which it is fully aligned.

Activities in PJ.13-01 will include ensuring a coherent approach to validation and testing across affected Solution projects, specifically PJ.10-05 and PJ.11-A2, including assessing and supporting the identification and development of suitable prototypes.

Solution PJ.13-01-01: Airborne Detect and Avoid Systems supporting integrated RPAS operations

Problem Statement:

RPAS Detect & Avoid (D&A) addresses the ability of RPAS to replicate the human ability to see and avoid. It is essential to have this capability as it is one of the cornerstones of aviation called "rules of the air" in which the pilot is ultimately responsible for the safety of the flight.

Solution Description :

The most important risk to mitigate in order for RPAS to operate in unsegregated airspace is the risk of mid-air collision. A D&A system is required for safe operations of RPAS in airspace shared with other aircraft, including manned aircraft.

Due to the fact that the pilot is not located on board the aircraft, but is remotely located, his/her ability to correctly judge the situation is impacted when needing to comply with ATC instructions, or to make decisions when not in receipt of an ATC service. The RPAS must be capable of detecting and avoiding cooperative and non-cooperative traffic and performing avoidance manoeuvres without inducing secondary conflicts. Avoidance manoeuvres can either be Collision Avoidance (CA) or Traffic Avoidance (TrA). The manoeuvre has to comply with the existing rules and regulations for manned aircraft. The D&A system for RPAS must issue instructions and/or take actions which, where appropriate, make it interoperable with present and future ACAS/TCAS systems.

In the international standardization community, important coordinated activity and standardization is taking place on the successor to the current ACAS (TCAS) system, and the new concept is called ACAS X. From a SESAR perspective, the whole ACAS X family is being researched within Project 11, with a solution (PJ.11-A2) dedicated to unmanned platforms, known as ACAS Xu. Although little work has so far been done on ACAS Xu, it is necessary to ensure that RPAS D&A work takes ACAS X developments fully into account, and that work is undertaken in a fully coordinated and standardized manner. Consequently, it is vital that this Solution is conducted with the closest cooperation with PJ.11, to minimize the risk of duplication or of conflicting initiatives. PJ.13 will be responsible for conducting the research into airborne D&A systems for RPAS, across the full range of RPAS operating environments, providing input to, and receiving help from, the PJ.11 Solution PJ.11-A2 on issues of relevance to ACAS Xu.

Specifically, this Solution will address:

- Traffic Avoidance against cooperative and non-cooperative traffic, replicating the ability of on-board pilots to separate themselves, without assistance from ATC, before any actual risk of collision occurs.
- Collision avoidance from cooperative and non-cooperative traffic, replicating the ability of on-board pilots to save the aircraft when an actual collision risk occurs.

The Wave 1 validation activity will concentrate on building on work already conducted in producing a Collision-Avoidance system for RPAS able to avoid co-operative traffic. This focus promotes a quick-win, able to support limited IFR integration into airspace where transponders are mandatory.

Wave 2 validation activities will further develop the CA systems to deal with non-cooperative traffic, thereby increasing relevance to the remaining airspace classes under both VFR and IFR. In addition, TrA will be addressed further supporting VFR flight in all airspace where such flight is permitted.

In both waves, C2 systems will be developed and updated to a level commensurate with the D&A technology under development.

Command and Control

C2 data link capability is a critical component of RPAS airborne D&A and the Solution will derive performance requirements commensurate with the needs of the solution and all the environments in which the RPAS is intended to operate.

Working closely with PJ.10-05 and PJ.11-A2, the following C2 data link work will be undertaken:

- *Required communication performance (RCP).* Definition of C2 Data link Operational and Safety Performance Requirements, i.e. assignment of RCP figures (availability, continuity, communication transaction time, integrity) to meet the needs of the D&A system, down to an apportionment to data link systems (RLOS and BRLOS), ensuring both safe operations as well as technical feasibility.
- *Architecture*. Development of an RPAS C2 system architecture that can meet the safety requirements for effective RPAS D&A:
  - C2 system trade-off analysis regarding C2 RCP apportionment to data link systems;
  - Definition of data link quality monitoring parameters for triggering contingency procedures; and
  - Analysis of security aspects to be included in the C2 system.

Contingency

The objective of the Contingency activity is to replace the decision authority of a human pilot on board of a manned A/C in the RPAS context to ensure safe operation under contingency or emergency conditions. Consideration needs to be given to contingency procedures, such as C2 loss but also other aspects such as emergency procedures for system failure or degradation of the D&A system and to determine if manned procedures can be used or need to be adapted, or whether totally new ones have to be defined.

In particular, the data link of an RPAS can be seen as the life-line of the system. When the link is severed the RPAS will become “uncontrolled” by the remote pilot and, because of this, it is essential that contingency procedures are developed. The loss of link does not imply the loss of the RPA, but it will not be able to receive any additional external inputs into the execution of D&A decisions.

The Solution will look not only at the technological issues associated with airborne D&A Systems, but it will also address the following transversal issues associated with the problem, as identified during the Definition Phase:

- Security;
- Cyber Resilience; and
- Human Factors.

<table>
<tr><td rowspan="4">**SESAR Solution PJ.13-01** Airborne Detect and Avoid Systems supporting integrated RPAS operations</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td><table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>EN1</td><td>Collision-Avoidance systems for RPAS D&A from cooperative traffic</td></tr>
<tr><td>EN2</td><td>C2 development to support Cooperative D&A</td></tr>
<tr><td>EN3</td><td>Contingency procedures for cooperative D&A</td></tr>
</table></td><td>N/A</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
<tr><td><table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>EN4</td><td>Collision-Avoidance systems for RPAS D&A against cooperative and non-cooperative traffic</td></tr>
<tr><td>EN5</td><td>Traffic Avoidance of cooperative and non-cooperative traffic in all airspace where VFR flight is permitted</td></tr>
<tr><td>EN6</td><td>C2 development to support cooperative and non-cooperative D&A</td></tr>
<tr><td>EN7</td><td>Contingency procedures for non-cooperative D&A</td></tr>
</table></td><td>N/A</td><td></td><td></td><td>V1</td><td>V2-V3</td></tr>
</table>

NOTE : New OIs will be created in DS15 for this SESAR solution

PJ.13-02 Systems enabling Integrated of General Aviation and Rotorcraft (GA/R) operations in the European Air Traffic Management System

Solution PJ.13-02-01: GA/R Specific Communication Systems

Solution Description :

This solution consists in the development of future communication enablers that are very specific to GA/R needs and to enable their integration into the ATM datalink environment and to benefit from the datalink applications:

- Development of low power and cost-effective datalink solution for GA/R (e.g. CPDLC, ADS-C) using appropriate technology (VHF, LDACS…).
- AGDL (Airport Ground Data Link) solutions for GA/R
- Investigate the feasibility of GSM-based terrestrial air-ground datalink for specific applications.
- Satellite communications will be considered (and may be appropriate, given GA/R's perceived lower integrity and continuity requirements).

Solution PJ.13-02-02: GA/R Specific Navigation Systems

Solution Description

This solution consists in the development of future navigation enablers that are very specific to GA/R needs and to enable their integration into performance based airspace:

- Technical enablers for GNSS-based precision operations:
    - Development of low power and cost-effective GNSS avionics (ARAIM,SBAS,GBAS) GA &R
    - Development systems for GA &R that can provide continuity (and if possible, availability) in the event of a GNSS outage (advanced AHRS, INS, …)
    - On-board solutions to support advanced\enhanced rotorcraft operations such as low level IFR routes in dense and complex airspace with connections to advanced (e.g. curved\tight RNP) SBAS based RNP APCH.

- Use of SVS\EVS\CVS (e.g. SBAS navigation supported by the use of enhanced vision systems) to enhance safety and accessibility when operating in small aerodromes (airports\heliports) in low visibility conditions.

Solution PJ.13-02-03: GA/R Specific Surveillance Systems

Solution Description

This solution consists in the development of future surveillance enablers that are very specific to GA/R needs and to enabling their integration to the future ATM environment:

- Development of low power and cost-effective ADS B-OUT solution for GA/R allowing Integration in ADS-B surveillance environment.
- Development of low power and cost-effective ADS B-IN solution and applications for GA/R to support the operational requirements emerging from the operational projects (e.g. Cockpit surrounding traffic display, situational awareness, separation, conflict detection & resolution)
- Cockpit Weather display

- Displays presenting symbology and imagery (SVS, EVS, CVS) to facilitate IFR-VFR transitions and for better situation awareness of terrain and obstacles in the air and on the ground.

Solution PJ.13-02-04: GA/R Specific Information Management systems

Solution Description

GA/R operations are dominated by single-pilot operations without an operations centre to support. Thus there is a need to ensure that the functions that the SESAR concept expects from an FOC can be reasonably carried out by such airspace users.

The equipment used by GAR to interact with the system needs to be cost-effective as well as interoperable with the rest of SWIM. This solution should therefore include an identification and assessment of appropriate SWIM profiles and services to enable off-the-shelf technology such as desktop PCs and mobile devices to perform the full range of flight management tasks including:

- Filing of flight plans (next flight) or re-routing / diversion;
- Trajectory negotiation and authorisation (for IFR flights);
- Aeronautical information management

Performance Goals

The objectives include, contribution to:

- Safety: RPAS D&A is a critical component of ensuring safe, integrated operations of RPAS in non-segregated airspace.
- Interoperability: RPAS D&A is required to ensure safe operations by unmanned platforms, but such systems must be interoperable with those of manned airspace users and not adversely impact such operations.
- Access and Equity: Improve accessibility to airspace and airports for RPAS, GA and Rotorcraft users, whilst maintaining or increasing the safety level of operations.
- Capacity: Allow accessibility to airspace for civil RPAS, whilst maintaining or increasing the safety level of operations.
- Cost-effectiveness: Cost is an important driver for solutions in the areas of RPAS and GA.

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.13-01-01 Airborne Detect and Avoid Systems supporting integrated RPAS operations	**L**	**L**	**L**	L	**H**	**L**	M	**L**	H	L	H	M
SOLUTION PJ.13-02-01 GA/R Specific Communication Systems	M	M	L	H	H	L	H	L	H	H	M	M
SOLUTION PJ.13-02-02 GA/R Specific Navigation Systems	M	M	L	H	H	L	H	L	H	H	M	M
SOLUTION PJ.13-02-03 GA/R Specific Surveillance Systems	M	M	L	H	H	L	H	L	H	H	M	M
SOLUTION PJ.13-02-04 GA/R Information management Systems	M	M	L	H	H	L	H	L	H	H	M	M

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G(Ground/Ground) or A/G(Air/Ground) integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.13-01-01 **Airborne Detect and Avoid Systems supporting integrated RPAS operations**	**N**	Changes expected both onboard and on ground.

SOLUTION PJ.13-02-01 **GA/R Specific Communication Systems**	N	Changes expected both onboard and on ground.
SOLUTION PJ.13 -02-02 **GA/R Specific Navigation Systems**	N	Changes expected both onboard and on ground.
SOLUTION PJ.13 -02-03 **GA/R Specific Surveillance Systems**	N	Changes expected both onboard and on ground.
SOLUTION PJ.13 -02-04 **GA/R Information management Systems**	N	Changes expected both onboard and on ground.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

SESAR Solution PJ.13-01-01: Airborne D&A Systems supporting integrated RPAS operations:

- Roadmap for the integration of civil RPAS into the European Aviation System;
- Activity descriptions from the SESAR Definition Phase reports;
- SESAR 1 RPAS Demonstration Project reports;
- Output from previous and simultaneous RPAS integration activities from around the world, such as, *inter alia*, ASTRAEA, MIDCAS and activities undertaken in the ICAO RPAS Panel and EUROCAE WGs 73 and 93; and
- Operational requirements from SESAR 2020 IR projects PJ.10-05 and PJ.11-A2.

SESAR Solution PJ.13-02-X: Systems enabling Integrated of General Aviation and Rotorcraft (GA/R) operations in the European Air Traffic Management System:

- SESAR 1 P04.10 D03 Platforms' adaptation and integration;
- SESAR 1 P04.10 D12 High Level Functional Airborne Architectures for Rotorcraft; and
- SESAR 1 Demonstration activity reports (EVA, E-CRA, PROuD).

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.13		
Source Project	Source Solution	PJ.13-01-01 Airborne Detect and Avoid Systems	PJ.13-02-02 GA/R Specific Navigation Systems	PJ.13-02-04 GA/R Information management Systems
PJ.01 Enhanced arrivals and departures	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA		▨	
PJ.10 Separation Management En-Route and TMA	PJ.10-05 IFR RPAS Integration	▨		
PJ.17 SWIM Infrastructures	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing			▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.01	PJ.02		PJ.03a		PJ.03b			PJ.07	PJ.10	PJ.11	
Source Project	Source Solution	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA	PJ.02-02 Enhanced arrival procedures	PJ.02-05 Independent Rotorcraft IFR operations at the Airport	PJ.03a-03 Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface	PJ.03a-09 Surface operations by RPAS	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.03b-05 Traffic alerts for pilots for airport operations	PJ.03b-06 Safety support tools for runway excursions	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.10-05 IFR RPAS Integration	PJ.11-A2 Airborne Collision Avoidance for Remotely Piloted Aircraft Systems	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations
PJ.13 Air Vehicle Systems	PJ.13-01-01 Airborne Detect and Avoid Systems					▨					▨	▨	
	PJ.13-02-01 GA/R Specific Communication Systems								▨	▨			
	PJ.13-02-02 GA/R Specific Navigation Systems	▨	▨	▨	▨				▨				
	PJ.13-02-03 GA/R Specific Surveillance Systems			▨	▨		▨	▨					▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Regarding PJ15 Common Services,

Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Dependencies with External Activities

The European RPAS Roadmap forms the foundation for the approach to progressively integrate RPAS into non-segregated airspace, fully aligned with ICAO ASBU and its three RPAS steps (blocks). The remaining R&D to be addressed in SESAR 2020 to meet the RPAS Roadmap's implementation timeline builds on the re-using past and existing D&A R&D on one hand, and closing remaining Gaps identified by the Roadmap on the other.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

The timely availability of D&A technologies in support of RPAS integration into non-segregated airspace is highly dependent on standardization, certification and regulation.

- Regulatory activities include coordination with the regulatory roadmap and its execution within/by EASA, JARUS, ICAO, EC SES, NSAs etc.
- Standardization work includes coordination and participation with EUROCAE (WG-73, 93), as well as forming international harmonization links to RTCA (e.g. SC-228 DAA MOPS, SC-147), and ICAO (RPAS Panel).
- Certification/approval processes involve EASA, NSAs and the involved manufacturers and end users.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

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    - ATC users requirements (ground & air),
    - RPAS capabilities and constraints
    - GA specific capabilities, needs and constraints

  - Airspace users, airport operators and airlines operators requirements,
  - Pilot/aircraft capabilities and constraints,
  - Military specific needs,
  - Validation methodologies,
  - MET expertise,
  - AIM expertise.
- System:
  - System engineering, prototyping,
  - System development,
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  - Quality management.
- Performance and Transversal Areas Assessments
  - Safety, security and environment performance measurement,
  - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
  - Technical expertise, knowledge and capabilities related to the European network as a whole,
  - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.
- Trans-European ATM Expertise to ensure the interoperability and connection to outside the ECAC.
- Detailed knowledge of the international standards and regulatory processes, and their responsible organisations.

Final deliverables for external publication/SESAR Solution Packs

- Feasibility report;
- Technical specifications;
- Cost benefit analyses;
- Preliminary Safety Cases;
- Interoperability specifications.

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

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C.14 Enabling Aviation Infrastructure – CNS (PJ14)

PJ.14	**CNS**

Problem Statement

CNS technologies on the ground and on-board 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 be considered as part of an integrated air and ground CNS system considering convergence towards a common infrastructure, and a unified concept of operations, where possible, across the different (COM, NAV and SURV) 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: at enforcing the new technical capabilities of CNS solutions in order to fully meet the requirements derived from operational needs, taking into account the features and edges of these new emerging CNS technologies but will also fully exploit their new capabilities.

Civil military CNS interoperability aspects and technology convergence must be covered in this project. The civil-military SWIM services in SESAR 2020 (see PJ.17) already address civil-military information exchange services. The Civil-military CNS interoperability activities will aim to focus on surveillance and mission trajectory information exchange in relation with the SWIM services.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

In 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.

Any SESAR solutions to be developed should be driven by operational requirements/concepts or strategic long term outlook.

For the integrated domain solutions proposed are:

- SESAR Solution PJ.14-01-01: CNS environment evolution;
- SESAR Solution PJ.14-01-02: CNS avionics integration;
- SESAR Solution PJ.14-01-03: CNS ground segment integration.

For the Communication domain solutions proposed are:

- SESAR Solution PJ.14-02-01: FCI Terrestrial Data Link;

- SESAR Solution PJ.14-02-02: Future Satellite Communications Data link;
- SESAR Solution PJ.14-02-04: FCI Network Technologies incl. voice solution and military interfacing;
- SESAR Solution PJ.14-02-05: Development of new services similar to FIS-B to support ADS-B solutions for General Aviation;
- SESAR Solution PJ.14-02-06: Completion of AeroMACS development.

For the Navigation domain solutions proposed are:

- SESAR Solution PJ.14-03-01: GBAS;
- SESAR Solution PJ.14-03-02: Multi Constellation / Multi Frequency (MC/MF) GNSS;
- SESAR Solution PJ.14-03-04: Alternative Position, Navigation and Timing (A-PNT).

For the Surveillance domain solutions proposed are:

- SESAR Solution PJ.14-04-01: Surveillance Performance Monitoring;
- SESAR Solution PJ.14-04-03: New use and evolution of Cooperative and Non-Cooperative Surveillance;

PJ.14 will make sure that GA/R and RPAS needs are integrated within the CNS solutions development. Effective coordination will be put in place with PJ.13 Air Vehicle Systems to validate the requirements and to ensure that specifics are covered.

PJ.14 will closely collaborate with the ATM solutions projects in order to:

- Define an efficient process for operational and performance requirements exchange avoiding gaps and overlaps.
- To plan the contribution to consolidated validation activities.
- Ensure that appropriate results and prototypes are delivered in support of the ATM solutions.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solution(s) PJ.14 Integrated

In each of the three (Communication, Navigation and Surveillance) domains, viewed all independently and, given increasing reliance on common infrastructure, as an integrated CNS system, functional and performance improvements have to be analysed, developed and validated, through a series of activities for both ground and airborne part.

For the integrated domain solutions proposed are:

- SESAR Solution PJ.14-01-01: CNS environment evolution;
- SESAR Solution PJ.14-01-02: CNS avionics integration;
- SESAR Solution PJ.14-01-03: CNS ground segment integration.

SESAR Solution PJ.14-01-01: CNS environment evolution

Solution Description

This SESAR Solution aims at identifying potential technological/functional synergies across the COM, NAV and SUR domains to benefit from common system/infrastructure capabilities for both ground and airborne segment. The goal is to evaluate and define evolutionary steps towards an efficient and reliable integrated CNS provision.

This SESAR Solution addresses also civil-military interoperability, GA & Rotorcraft and RPAS with tight PJ.13 coordination to ensure that there are no overlaps with the PJ.13.

SESAR PJ.14 Solution 14-01-01 shall be considered as a federated project providing inputs and requirements to Solution 14-01-02 and Solution 14-01-03. An essential participation of ground and airborne partners in Solution 14-01-01 will ensure good interfaces within all solutions of the domain Integrated 14-01.

Activities to be done

- CNS Requirements, Threats and Vulnerability Assessment:
    - Collection and analysis of current CNS requirements (operational, safety, security, performance);
    - CNS robustness studies and guidelines regarding interference, safety and security including those caused by non-ATM systems and technology;
    - Space weather and ionosphere modelling.
- Integrated CNS design and specification:
    - Integrated CNS architecture definition to be used as basis for SESAR 2020 ATM design.
    - Benefits study of functional and/or hardware CNS integration, CNS data fusion including ground and airborne data fusion/hybridization of multiple sensors/systems/units;
    - Inspection of consolidated system capability and service performance assumptions (virtual simulation and modelling to prove proposed approaches) including safety assessment;
    - Performance monitoring and prediction aspects in order to support a more flexible and efficient use of the airspace, improving the automation level through the use of innovative technologies and the infrastructure evolution;

  - Navigation System Performance and Requirements analysis and update to take into account the new sources of navigation such as:
    - multi-constellation operation (mainly GPS-Galileo)
    - modernized SBAS systems, (in particular EGNOS V3);
    - GBAS GAST-F and GAST-D (low/high latitudes)
    - multi-frequency (in particular L1/L5);
  - Assessment of the robustness mitigation and common failure modes in an integrated CNS System, particularly use of an integrated modular avionics approach for ATR, Bizjets, GA and RPAS applications.
- Efficient CNS Provision:
  - Integrated CNS spectrum planning including civil-military coordination and aviation frequency bands CNS technology sharing;
  - Cost efficiency analysis for both ground and airborne segment.
- Civil-military CNS interoperability:
  - Civil-military CNS interoperability aspects including identification of interoperability targets to support performance based compliance;
  - Validation of CNS information exchange between ATM and military units:
    - Assessment of cooperative surveillance data confidence for military needs in liaison with PJ.14-04-03;
    - Integration and fusion of the CNS data by military units;
    - Shared information picture between civil and military entities.

Level of Maturity

PJ.14-01-01 activities will continue work from:

- Project 15.01.07: CNS System of System Definition and Roadmap; D01, D02, D03, D04, D05
- Project B4.2 ADDs

PJ.14-01-01 activities will use as a inputs results coming from:

- Project 15.04.01: Surveillance infrastructure rationalisation study;
- Project 15.04.02: Integrated Surveillance Sensor Technologies;
- Project 15.02.04: Future Mobile data Link system definition.

PJ.14-01-01 activities will follow approaches and roadmaps formulated in Project 9.49.: (Global Interoperability - Airborne Architecture and Avionics Interoperability Roadmap) and propose improvement where identified as necessary.

The level of maturity for this solution should be increased to level 2 at the end of SESAR 2020's first wave. This solution creates a prerequisite for solutions PJ.14-01-02 and PJ.14-01-03.

Expected outcomes (and deliverables)

- CNS strategy document.
- Concepts of operations for integrated CNS environment.
- Integrated CNS requirements achievability.

- Updated navigation performance requirements and operational concept using enhanced navigation capabilities (MF/MC GNSS, ARAIM, SBAS, GBAS…)
- Feasibility study for ground and airborne segment optimization.
- RF interferences study.
- Safety assessment for integrated CNS environment.
- Integrated CNS architecture report.

Major links and dependencies

Active coordination with ICAO, EUROCAE,/RTCA, AEEC and FAA:

- WG-72 / Aeronautical Systems Security;
- WG-78 / Standards for Air Traffic Data Communication Services;
- Coordination with FAA;
- Work Program of the ICAO Communications Panel (CP) and Navigation Systems Panel (NSP).

Links to PJs implementing future concepts is provided in the dependency table.

Links to SESAR 1 implementing future concepts:

- Project 15.01.06: Spectrum management and impact assessment;
- Project 15.01.07: CNS System of System Definition and Roadmap;
- Project 15.04.01: Surveillance infrastructure rationalisation study;
- Project 15.04.02: Integrated Surveillance Sensor Technologies;
- Project 15.02.04: Future Mobile data Link system definition.

Validation of the Solution

Integrated CNS benefits will be validated through simulation and modelling activities.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-01-01 **CNS environment evolution**	**MATURITY**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
OI Step and Title	N/A	V		V	V3

Enabler	Enabler Title		1		2	
CTE-C01	A/G Voice radio					
CTE-C02	A/G Data link radio					
CTE-C02g	Air to Air functionality of New A/G radios					
CTE-C03	Commercial Telecom Infrastructure (SATCOM, Gatelink)					
CTE-C06	Ground ATM Data communication Network					
CTE-C06d	Gateway for CIV/MIL Interoperability					
CTE-CGOV02	Data and voice Communications Service Provision for ATS and AOC services					
CTE-N01	GPS L1/L5					
CTE-N02	GALILEO E1/E5					
CTE-N03	GLONASS-K					
CTE-N04	BEIDOU B1/B5					
CTE-N05	GNSS performance assessment system					
CTE-N06	Space Based Augmentation System (SBAS)					
CTE-N07	Ground Based Augmentation System (GBAS)					
CTE-N08	DME Ground Infrastructure optimisation					
CTE-N11	NDB Decommissioning					
CTE-N12	VOR/DME MON					
CTE-N13a	A-PNT (Alternative Positioning Navigation and Timing)					
CTE-NGOV01	Ground Navaids Optimisation/Rationalisation Plans					
CTE-S02	Primary SUR sensor					
CTE-S02c	Multi Static Primary Surveillance Radar					
CTE-S02d	Video Surveillance					
CTE-S03	ADS-B Receiving Station					
CTE-S03d	Satellite based ADS-B technology					
CTE-S04	Multilateration ground System					
CTE-SGOV02	SUR Infrastructure rationalisation					

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SESAR Solution PJ.14-01-02: CNS avionics integration

Solution Description

This SESAR Solution aims at identifying potential technological, operational and functional synergies across the COM, NAV and SUR domains to benefit from common avionics systems capabilities.

Activities to be done

- Identification of avionics CNS subsystems suitable for integration.
- Cost Benefit Analysis for integrated avionics architecture for ATR, BGA, helo and RPAS platforms.
- Integrated CNS architecture as an input to SESAR2020 ATM Design & Integration project (PJ.19).
- Avionics system prototype integrating multiple CNS systems. This part of the activities is related to the Avionics suppliers and will be activated only in case of their presence.
- Standardization and certification work on integrated CNS avionics.
- Flight worthy prototype solution of shared information picture to support the validation of the CNS information exchange.
- Tests in integrated CNS environment test bed.
- Full air/ground interoperability test.
- Flight Tests of integrated CNS avionics.

Level of Maturity

Solution PJ.14-01-02 activities will continue work from:

- Project 15.01.07: CNS System of System Definition and Roadmap; D01, D02, D03, D04, D05.

Solution PJ.14-01-02 activities will use as a inputs results coming from:

- Project 15.01.06: Spectrum management and impact assessment;
- Project 15.04.01: Surveillance infrastructure rationalisation study;
- Project 15.04.02: Integrated Surveillance Sensor Technologies;
- Project 15.02.04: Future Mobile data Link system definition;
- Project 9.44: Flexible Communication Avionics.

Solution PJ.14-01-02 activities will follow approaches and roadmaps formulated in Project 9.49: (Global Interoperability - Airborne Architecture and Avionics Interoperability Roadmap) and propose improvement where identified as necessary.

Development of new prototypes and standards (ICAO, EUROCAE/RTCA, AEEC and potentially EASA/ETSI).

The level of maturity for this solution should achieve level 1 during the project execution and should be increased to level 2 at the end of SESAR 2020’s first wave. Significant prototyping and testing effort is assumed. Level 3 maturity achievement, for some components derived from this solution, is assumed at the end of SESAR2020’s second wave.

Expected outcomes (and deliverables)

- Integrated CNS avionics Architectural report.
- Technical specification of prototype.

- Safety analyses of proposed architecture.
- Flight worthy avionics prototype.
- Prototype test report.
- Standardization documents inputs.

Major links and dependencies

Essential links providing requirements and inputs for full air/ground integrated CNS interoperability:

- Solution PJ.14-01-01: CNS environment evolution;
- Solution PJ.14-01-03 - CNS ground segment integration.

Active coordination with ICAO, EUROCAE,/RTCA, AEEC and FAA:

- WG-72 / Aeronautical Systems Security;
- WG-78 / Standards for Air Traffic Data Communication Services;
- Coordination with FAA.

Links to PJs implementing future concepts is provided in the dependency table.

Links to SESAR 1 implementing future concepts:

- Project 15.01.07: CNS System of System Definition and Roadmap;
- Project 15.04.01: Surveillance infrastructure rationalisation study;
- Project 15.04.02: Integrated Surveillance Sensor Technologies;
- Project 15.02.04: Future Mobile data Link system definition;
- Project 9.44: Flexible Communication Avionics.
- Project 9.02: Full 4D

Validation of the Solution

Integrated CNS benefits will be validated through integration of avionics prototype.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

<table>
<tr><td colspan="2" rowspan="4">SOLUTION PJ.14-01-02
CNS Avionics integration</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td colspan="2">OI Step and Title</td><td rowspan="3">N/A</td><td rowspan="3"></td><td rowspan="3">V1</td><td rowspan="3">V2</td><td rowspan="3">V3</td></tr>
<tr><td>Enabler</td><td>Enabler Title</td></tr>
<tr><td>CTE-C01</td><td>A/G Voice radio</td></tr>
</table>

CTE-C02	A/G Data link radio					
CTE-C02g	Air to Air functionality of New A/G radios					
CTE-C03	Commercial Telecom Infrastructure (SATCOM, Gatelink)					
CTE-C06	Ground ATM Data communication Network					
CTE-C06d	Gateway for CIV/MIL Interoperability					
CTE-CGOV02	Data and voice Communications Service Provision for ATS and AOC services					
CTE-N01	GPS L1/L5					
CTE-N02	GALILEO E1/E5					
CTE-N03	GLONASS-K					
CTE-N04	BEIDOU B1/B5					
CTE-N05	GNSS performance assessment system					
CTE-N06	Space Based Augmentation System (SBAS)					
CTE-N07	Ground Based Augmentation System (GBAS)					
CTE-NGOV01	Ground Navaids Optimisation/Rationalisation Plans					
CTE-SGOV02	SUR Infrastructure rationalisation					

SESAR Solution PJ.14-01-03: CNS ground segment integration

Solution Description

This SESAR Solution aims development and implementation of COM, NAV and SUR infrastructure elements identified in Solution PJ.14-01-01.

Activities to be done

- CNS Infrastructure modification plan incorporating legacy and new requirements from all airspace users.
- Integrated CNS environment test bed development (including prototypes and simulators).
- One of the tasks is the coordination with the C, N, S solutions development. In order to avoid competitive solutions.
- Full air/ground interoperability test.

Level of Maturity

Solution PJ.14-01-03 activities will continue work from:

- Project 15.01.07: CNS System of System Definition and Roadmap; D01, D02, D03, D04, D05.

Solution PJ.14-01-03 activities will use as a inputs results coming from:

- Project 15.04.01: Surveillance infrastructure rationalisation study;
- Project 15.04.02: Integrated Surveillance Sensor Technologies;
- Project 15.02.04: Future Mobile data Link system definition.

Solution PJ.14-01-03 activities will follow approaches and roadmaps formulated in Project 9.49: (Global Interoperability - Airborne Architecture and Avionics Interoperability Roadmap) and propose improvement where identified as necessary.

Development of new prototypes and standards (ICAO, EUROCAE/RTCA, AEEC and potentially EASA/ETSI).

The level of maturity for this solution should achieve level 1 during the project execution and should be increased to level 2 at the end of SESAR 2020's first wave. Significant testing effort (in coordination with PJ.14-01-02) is assumed. Level 3 maturity achievement, for some components derived from this solution, is assumed at the end of SESAR2020's second wave.

Expected outcomes (and deliverables)

- Integrated CNS infrastructure roadmap.
- Performance and cost assessment comparing legacy and integrated approaches.
- Safety impact analyses.
- Simulations and Tests reports.

Major links and dependencies

Essential links providing requirements and inputs for full air/ground integrated CNS interoperability:

- Solution PJ.14-01-01: CNS environment evolution;
- Solution PJ.14-01-02: CNS avionics integration.

Active coordination with ICAO, EUROCAE,/RTCA, AEEC and FAA:

- WG-72 / Aeronautical Systems Security;
- WG-78 / Standards for Air Traffic Data Communication Services;
- Coordination with FAA.

Links to PJs implementing future concepts is provided in the dependency table.

Links to SESAR 1 implementing future concepts:

- Project 15.01.07: CNS System of System Definition and Roadmap;
- Project 15.02.04: Future Mobile data Link system definition.

Validation of the Solution

Integrated CNS benefits will be validated through end-to-end prototype integration.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-01-03 **CNS ground segment integration**		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
OI Step and Title		N/A			V1 / V2	V3
Enabler	**Enabler Title**					
CTE-C01	A/G Voice radio					
CTE-C02	A/G Data link radio					
CTE-C02g	Air to Air functionality of New A/G radios					
CTE-C03	Commercial Telecom Infrastructure (SATCOM, Gatelink)					
CTE-C06	Ground ATM Data communication Network					
CTE-C06d	Gateway for CIV/MIL Interoperability					
CTE-CGOV02	Data and voice Communications Service Provision for ATS and AOC services					
CTE-N01	GPS L1/L5					
CTE-N02	GALILEO E1/E5					
CTE-N03	GLONASS-K					
CTE-N04	BEIDOU B1/B5					
CTE-N05	GNSS performance assessment system					
CTE-N06	Space Based Augmentation System (SBAS)					
CTE-N07	Ground Based Augmentation System (GBAS)					
CTE-NGOV01	Ground Navaids Optimisation/Rationalisation Plans					
CTE-SGOV02	SUR Infrastructure rationalisation					

SESAR Solution(s) PJ.14 Communications

The future data links on the ground and on-board the aircraft are an essential underlying technical enabler for many of the operational improvements and new procedures being developed within SESAR. The future data links must take a service and business-oriented approaches with efficient use of resources delivering the required capability in a cost-effective and spectrum efficient manner. The optimisation of the use of radio spectrum is thus a key goal of the future data link development and rationalisation. The development of the future data links is based on the work performed in SESAR1 and split into five solutions:

- SESAR PJ.14 Solution 14-02-01: FCI Terrestrial Data Link
- SESAR PJ.14 Solution 14-02-02: Future Satellite Communications Data link
- SESAR PJ.14 Solution 14-02-04: FCI Network Technologies incl. voice solution and military interfacing
- SESAR PJ.14 Solution 14-02-05: Development of new services similar to FIS-B to support ADS-B solutions for General Aviation;
- SESAR PJ.14 Solution.14-02-06: Completion of AeroMACS development.

SESAR Solution PJ.14-02-01: FCI Terrestrial Data Link

Solution Description

The increase of ATM performance requirements, due to the growth of air traffic and its complexity, raises the need to introduce an appropriate data link solution in order to support the air traffic services evolution according to the ICAO technology roadmaps and the ATM key improvement areas as defined in the ATM master plan. In particular, the 4D trajectory management operational concept needs to be supported by a reliable, scalable, modular and efficient data link technology. This solution addresses the development of the future terrestrial A/G and A/A data link.

The future terrestrial data link L-DACS (L-band digital aeronautical communications system) shall be based on the work performed on L-DACS1 in SESAR1 and aligned with international standardisation activities. There is a need for investigations to support the selection of the technology at a global level (ICAO) and support to the standardisation as required in ICAO, EUROCAE/RTCA and AEEC. The activities will include technical validation (leading to publication of standards) as well as operational validation involving candidate/representative applications.

This solution will address both avionics and ground implementations.

The scope is to provide a direct benefit to the SESAR Performance Target (e.g. Air Space capacity) by:

- Finalization of the development and standardization of the LDACS technology.
- Development of LDACS system architecture.
- Development and validation of a fully functional LDACS prototype
- Assessment of impact on external systems (interference to military systems e.g. JTIDS/MIDS, TACAN)
- Development of technologies for digital voice.
- Analyse specific solutions for broadcast applications (including uplink of airspace management data as needed for PJ.08)

In addition, the following transversal topic shall be addressed:

- Development of a concept for the seamless migration from existing data link technologies to

LDACS.
- Assess synergy offered by LDACS through making available a ranging/navigation functionality for APNT also taking a business view regarding rationalization potential compared to other solutions into account.

Activities to be done

Indicative activities for LDACS include:

1) Development (or finalization) of prototypes to complete testing and in particular spectrum compatibility:
- Development, verification, and validation of a fully functional LDACS prototype.

2) Development/Completion of proposed technical specifications:
- Review and finalization of LDACS specification for A/G.
- Development of an LDACS airborne and ground system architecture including interfaces to the mobile network in the aircraft and to the Ground ATN/IPS network.
- Development, specification, and demonstration of a security concept for LDACS.
- Development of a concept for seamless migration from existing data link technologies to LDACS.
- Development of a deployment concept in L-band allowing coexistence with legacy systems.
- Dependent on the assessed synergy potential an integration of a ranging functionality into LDACS which serves as ranging sensor for an APNT (Alternative Positioning, Navigation, and Timing) system will be developed.
- Development and specification of an Air-to-Air functionality within LDACS.
- Review and finalization of a digital voice communication solution over LDACS (VoIP)
- Definition of broadcast solutions including for the uplink of airspace management (ASM) data. Such service would also support important Mission Trajectory requirements.

3) Coordination and harmonisation at global level of proposed solution:
- Coordination with Work Program of the ICAO Communications Panel (CP) and the Navigation Systems Panel (NSP).
- Coordination with standards activities performed within ICAO, EUROCAE/RTCA, and AEEC.

4) Validation and agreement of required standards.

5) Laboratory testing and flight trials for operational validation of solution.

Level of Maturity

For LDACS there is some work from past activities in particular P15.2.4 and P15.1.6, so PJ.14 activities will continue the work carried in these Projects:
- Early Working Activities (EWA) within SJU project P15.2.4:
  - D30: EWA04-1-T1-D1: Preliminary Report on Interference Mitigation Techniques
  - D31: EWA04-1-T1-D2: Intermediate Report on Interference Mitigation Techniques
  - D32: EWA04-1-T2-D1: Updated L-DACS1 System Specification
  - D33: EWA04-1-T2-D2: Updated L-DACS1 Prototype Specification
  - D34: EWA04-2-T1-D1: Updated Compatibility Criteria of existing L band systems
  - D36: EWA04-2-T2-D1: Initial Testing Plan for LDACS
  - D37: EWA04-3-T2-D2: Intermediate report on the achieved LDACS1 prototyping status

- SJU Project P15.2.4:
    - D21: Test Plans for LDACS Assessment
    - D22: LDACS1 Transmitter Test Report
    - LDACS1 Demonstrator Development (Transmitter) for Compatibility Testing (as reported in D21 and D22)
- SJU Project P15.1.6:
    - D06: “Scenario description for LDACS1&2”
    - D07: “LDACS1&2 Compatibility Report”
    - D08: “Final LDACS1&2 Compatibility Report”

The current LDACS maturity level is V2. The objective of this project is V3. The main remaining work to achieve V3 is to finalize the LDACS specification including above mentioned extensions towards A/A functionality, security concept, digital voice, and ranging functionality, to implement a fully functional LDACS demonstrator, and to validate the LDACS demonstrator in laboratory and flight trials. In addition, concepts for L-band deployment and the migration from existing data link technologies to LDACS have to be developed.

Expected outcomes (and deliverables)

LDACS: A/A functionality concept, security concept, concept for inclusion of digital voice, ranging functionality concept, final LDACS system specifications, Interface specifications to the mobile and Ground ATN/IPS networks, LDACS prototype, support to standardization (ICAO, EUROCAE/RTCA and AEEC), L-band deployment concept, migration concept from existing data link technologies to LDACS, safety analysis and CBA (to support implementation decision making).

Major links and dependencies

Active coordination with ICAO, EUROCAE,/RTCA, AEEC and FAA:

- WG-82 / New Air-Ground Data Link Technologies
- WG-72 / Aeronautical Systems Security
- WG-78 / Standards for Air Traffic Data Communication Services
- WG-85 / 4D Navigation
- Coordination with FAA
- Work Program of the ICAO Communications Panel (CP) and Navigation Systems Panel (NSP).
- LDACS standardization activities performed within ICAO, EUROCAE/RTCA, and AEEC.

Links to PJs implementing future concepts is provided in the dependency table.

Validation of the Solution

LDACS testbed(s)

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

<table>
<tr><td colspan="2" rowspan="4">SOLUTION PJ.14-02-01
FCI Terrestrial Data Link</td><td colspan="5">MATURITY</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
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<tr><td colspan="2">OI Step and Title</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Enabler</td><td>Enabler Title</td></tr>
<tr><td>CTE-C02e</td><td>New A/G Data link using ATN/IPS over L-band</td><td>V1/V2</td><td></td><td></td><td>V2/V3</td><td>V3</td></tr>
<tr><td>CTE-C02g</td><td>A/A functionality</td><td>N/A</td><td></td><td></td><td>V1</td><td>V2</td></tr>
<tr><td>CTE-C01b</td><td>New Digital Voice</td><td>N/A</td><td></td><td></td><td>V2</td><td>V3</td></tr>
<tr><td>CTE-N13a</td><td>A-PNT (Alternative Positioning Navigation and Timing)</td><td>V1</td><td></td><td></td><td>V2</td><td>V3</td></tr>
</table>

SESAR Solution PJ.14-02-02: Future Satellite Communications Data link

Solution Description

In order to support the future ATM concept in the 2020+ timeframe is required a future satellite (i.e. Long Term SATCOM) data link technology for the continental and oceanic region including digital voice as element of the Future Communication Infrastructure (FCI).

The selection of technology for the future satellite Data link and related standardization is an activity already started in SESAR 1 that needs to be completed. The necessary activities include future satellite Data link technical validation (leading to publication of standards) as well as operational validation involving candidate/representative applications.

The future satellite data link shall be based on the work performed on Long Term SATCOM in SESAR1 and ESA Iris Programme and aligned with international standardisation activities as required in ICAO, EUROCAE/RTCA and AEEC. Currently the NEXUS WG is defining the new communication performance for Long term SATCOM (Class A) and for an intermediate step for initial 4D (i4D) SATCOM services (Class B).

The future satellite Data link validation will exploit ground and airborne prototypes in coordination with ESA/Iris Long term solution as required.

Activities to be done

Indicative activities for Long Term SATCOM Data link include:

1) Development/Completion of Technical Specifications including safety and security for Long Term SATCOM:
    a. Define a seamless transition from SESAR baseline to Iris Long Term (Class A) integrated in the FCI based on IPv6 and ATN/IPS stack considering the intermediate step of the i4D SATCOM services based on the ESA Iris Precursor solution (Class B)
2) Develop and specify a performance monitoring & control concept for seamless integration of

Long Term SATCOM within an ATN/IPS network implementing a multilink policy in order to be able to validate the multilink concept implementation

3) Reuse and consolidation of ground and airborne prototypes to allow satellite Data link validation.
4) Coordination with ESA Iris Long Term and harmonisation at global level of proposed solution
5) Develop and finalize the specification of a digital voice communication solution over SATCOM (VoIP) Data link for emergency and non-routine procedures in ORP
6) Validation and agreement of required standards
7) Testing by test beds and Flight trials for operational validation of critical functions, ensuring at early stages (wave 1) robustness of Data link in front of internal/external interferences and, at wave 2, single performance readiness to validate FCI multilink concept requested for full 4D service provision.

Level of Maturity

SESAR 1 P15.2.6 worked on Long Term SATCOM defining initial versions of the Mission Requirements, SESAR Interfaces and Validation and Verification procedures. PJ.14 activities will continue the work carried in P15.2.6 with ESA Iris Programme coordination.

SESAR 1 P15.2.5 is aimed to define and develop the Iris Precursor solution in coordination with ESA Iris Precursor Study.

User terminal and Ground station prototypes are developed within ESA Artes 10 Programme (TRL5\TRL6)

Expected outcomes (and deliverables)

Long Term SATCOM: Data link technical validation, prototypes consolidation, support to standardization (ICAO, EUROCAE/RTCA and AEEC), safety and security analysis.

Major links and dependencies

Active coordination with FAA and ICAO:

- Work Program of the ICAO Communications Panel (CP) and Navigation Systems Panel (NSP) for AMS(R)S SARPS edition.
- WG-82 / New Air-Ground Data Link Technologies to define the MASPS and MOPS documents for Class B (ATN-Baseline 2) and class A (ATN - Baseline 3)
- WG-72 / Aeronautical Systems Security
- WG-78 / Standards for Air Traffic Data Communication Services

Links to PJs implementing future concepts is provided in the dependency table.

Validation of the Solution

Long Term SATCOM testbed(s) based on Iris Verification Test Beds.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-02-02 **Future Satellite Communications Data link**		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
CNS-0001-B/C Rationalisation of COM systems/infrastructure for Step 2/Step3						
CTE-CGOV01/02	Data & Voice service in integrated architecture.				V1-V2	V3/TRL6
CTE-C02f	Future SATCOM for ATM (Long Term SATCOM)				V1-V2	V3/TRL6
CTE-C01b	New Digital Voice				V1/V2	V3
AOM-0208-C Dynamic Mobile Areas (DMA) of type 3						
CTE-C02f	Future SATCOM for ATM (Long Term SATCOM)					V3/TRL6
CM-0607 Separation Management in En Route using RBTs with 2D RNP Specifications						
CTE-C02f	Future SATCOM for ATM (Long Term SATCOM)					V3/TRL6
CM-0608 Separation Management in the TMA using RBTs with 2D RNP Specifications						
CTE-C02f	Future SATCOM for ATM (Long Term SATCOM)					V3/TRL6
MET-0301 Enhanced MET observations, nowcasts and forecasts provided by ATM-MET systems through information provided by ATM systems and aircraft, Step 3						
CTE-C02f	Future SATCOM for ATM (Long Term SATCOM)					V3/TRL6

SESAR Solution PJ.14-02-04: FCI Network Technologies incl. voice solution and military interfacing

Solution Description

A Future Communications Infrastructure (FCI) shall be developed for trajectory based operations and to support new advanced operational concepts by taking developed requirements into account. Future ATS and AOC services, even if they have different targets and different Quality of Service, will demand higher data link communication capacity and better performance of any kind of communication than the current system can offer.

This solution will continue the P9.44 and P15.2.4 SESAR1 work in relation to software radio architectures, ATN/IPS and Multilink. It will support the required developments in relation to software radios and will finalise the required development, validation of the ATN/IPS and the definition and specification of the multilink function for the ground and the airborne side. The developed solutions needs to address the security aspects and support a seamless migration/transition from existing data link technologies to new terrestrial and satellite data links (including mixed mode FANS, OSI and IPS operational environment(s). This solution shall also address the future voice communication solution in a 4D trajectory based and sector-less environment. In addition, the following transversal topics have to be addressed for Data Link Solution:

- Communication system performance monitoring and supervision
- Ground and A/G Cyber Security aspects.
- Civil-Military requirements and interfacing/interoperability between civil-military ground-ground communications networks. This topic comprises the definition of ground-ground interface to address communication mismatches between lower OSI layer protocols, AFTN-AMHS, AMHS to MMHS, directory services, FMTP and security, as well as to complete the integration with the military air-ground segment for seamless ATN air/ground operation (building on the results of SESAR 1 9.20 and 15.2.8)
- Evolution of G/G to increase the level of IPv6 communication supporting ATN/IPS with consideration of transition issues from IPv4 as well as routing, addressing, mobility and OSI-to-IPS transition.

<u>Activities to be done</u>

The following high level activities are foreseen:

- Indicative activities for software defined radios will be based on the P9.44 outcome and will include a flexible physical hardware to support reconfiguration capabilities, e.g. to become compliant to standard updates, etc.
- Indicative activities for network aspects will be based on the SESAR1 P15.02.04 activities for IPS. They include a concept of operation for the FCI based on the work done in P15.02.04 but extended by all G/G applications, SWIM and other services like voice/VOIP, etc. Furthermore, these activities will complete and validate as required developments and in particular will cover development of prototypes for IPS cockpit connectivity for ATM purposes.
- Indicative activities for multilink aspects will be based on the SESAR1 P15.02.04 activities for multilink (including link selection, seamless transitions between links, handover, etc.) They include the evolution of the ground ATM COM infrastructure to cover the routing and networking capabilities including security considerations to support the future IP based data links both as standalone (i.e. for AeroMACS in the short to medium term) and in a multilink environment comprising AeroMACS, LDACS, and long-term SatCom (FCI in general in the medium to long term).
- Indicative activities for voice communication will be based on the SESAR P 15.01.07 activities for voice communications. The current VHF Frequency coverage is inflexible and unusable for future operations. A new communication concept have to be invented for voice communication to support the required flexibility required for time-critical and emergency communication in an sector-less environment. This shall include solutions for cross-ANSP and support the concept of remote tower for multiple airports.
- Indicative activities for interfacing/interoperability between civil-military ground-ground communications networks, based on the results of SESAR1 P15.02.10 activities, to address protocol mismatches in OSI layers 1 to 3, dual-stack alternatives to ensure full flexibility of communications from X.25 and IPv4 to IPv6 supporting FMTP, identifying technical solutions for the interoperability with legacy AFTN tails and between AMHS and military MMHS X400, to define QoS in line with operational usage and to identify specific solutions for address management, directory services and security. This work shall be considered as complementary to PJ.17 efforts to address military aspects when consolidating SWIM profiles and reference

models and when developing bridges applicable to OSI layers 4 and above. The results must be validated through testbeds.

- In addition, for the seamless integration of ground networks and air-ground segment, those activities will also ensure that the solutions deliverable by projects 9.20 and 15.2.8 for military data link accommodation can be integrated in the SESAR ground communications environment including the definition of solutions to address bandwidth management issues, ATN mobility management and encapsulation needs, separation red/black and inputs to multilink solutions considering also the outcomes of 15.2.4. The results must be validated through testbeds.
- In order to improve the security of data and information exchange, a Common Security Framework should be defined. A security target must be identified driven by ISO 27001 so to build a framework based both on technology and processes
- Definition and standardization of Network and Security requirements (e.g. Certificate Profile definition, with agreement on Certification Authority, definition of Ground Network Protocols, etc.)
- Multicast/Broadcast (MBS) Algorithms definition.
- Current solutions do not clearly address data link safety requirements that are left to the system providers, in terms of overall availability. The use of Software Defined Radios (for example) could enable providing systems that are able to be reconfigured to any waveform, according to the required crisis scenario mitigation; moreover, the robustness of the data link against intentional or unintentional interferences must be verified and if needed reinforced
- Current solutions do not address security and data integrity aspects. Authentication and air interface encryption shall be mandatory, but they are meaningless without a global, federated “system of Public Key Infrastructures” that shall be able to create, update and revoke certificates available and trustable among all the stakeholders.

Level of Maturity

Activities of this solution will continue work from P9.44, P15.2.4, P15.2.8, P15.2.10 and P15.1.7

- SJU Project P15.2.4: D03, D04, D09, D10, D16
- SJU Project P15.2.10: D04, D05, D06, D10, D11, D12
- SJU Project P15.1.7: D01, D04, D05
- SJU Project P15.2.8: D01 to D11

Prototypes and standards (ICAO, EUROCAE/RTCA, AEEC and potentially EASA/ETSI)

Major links and dependencies

Active coordination with ICAO, EUROCAE,/RTCA, AEEC and FAA:

- Work Program of the ICAO Communications Panel (CP).
- Standardization activities performed within ICAO, RTCA, and EUROCAE.
- WG-72 / Aeronautical Systems Security
- WG-78 / Standards for Air Traffic Data Communication Services

Links to PJs implementing future concepts is provided in the dependency table.

Links to PJ.14 solutions:

- Solution PJ.14-01-01 - CNS environment solution;
- Solution PJ.14-02-01 - FCI Terrestrial Data Link;

- Solution PJ.14-02-02 - Future Satellite Communication Data link;
- Solution PJ.14-02-06 - Completion of AeroMACS development.

Validation of the Solution

Testbeds for the various components of the solution (IPS, SDR, Voice, Civil-Military Interface, Multilink, Cyber security, PKI infrastructure) and likely integrating them also in the testbeds from the FCI solution.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-02-04 **FCI Network Technologies incl. voice solutions and military interfacing**		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
OI Step and Title						
Enabler	**Enabler Title**					
CTE-C04	Routing/Networking Ground Infrastructure for future A/G Data link (Multilink)	V1			V3	
CTE-C01	A/G Voice radio - Existing and New A/G Voice Infrastructure	N/A		V2	V3	V3+
CTE-C05b[12]	Digital Voice / VoIP for ground segment of Air-Ground voice: - Voice over IP (VoIP), based on ED137B VOL1: RADIO, is deployed for the Ground-Ground segment of the ATM Air-Ground voice communication. Networking of Radios is implemented to support the Dynamic Cross-border sectorisation	V1			V3	

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[12] Related only to enhanced ATM voice systems to support remote tower with multiple airports and ATM sector less environment

CTE-C06	An IP-based secured network communication service for the connected ANSPs, NM systems (incl. EAD) across the Pan-European region which enables the implementation of AMHS, FMTP, Surveillance data exchange, VoIP (radio and telephony).					
CTE 06b	PENS phase 2: PENS phase 1 and in addition connectivity to other ATM Users and new Data link systems (SATCOM, AeroMACS, LDACS) as they become available. Covers potential infrastructure improvements to cover new requirements		V3			
MIL-0501	Specifications for the interoperability of military ground systems with SWIM: - Develop specifications of the upgrades that are needed to allow ground military systems to consume and provide SWIM services. These specifications include any additional control and protection the military systems may require and the integration of military specificities in the SWIM data models					
MIL – 0502	Update of the military ground systems with the additional control and protection needed for inter-operation with non-military IP networks (for instance PENS or an IP VPN)					
CTE-C06d	“Gateway for CIV/MIL Interoperability”. Gateway supporting CIV/MIL Interoperability for Military Aircraft equipped with military Data link. Military	N/A			V3	

		aircraft equipped with military data link are able to exchange data messages with ATM systems via gateways/interfaces with the adequate performance provided that solutions are found to avoid negative impact on DME performance, and that institutional constraints of using such technology in support of ATM functions are solved				

SESAR Solution PJ.14-02-05: Development of new services similar to FIS-B to support ADS-B solutions for General Aviation

Solution Description

ADS-B, which consists of two different services, "ADS-B Out" and "ADS-B In", could complement radar as a surveillance method for controlling aircraft worldwide. It is already mandated in US (incl. GA) and in Europe. ADS-B enhances safety by making an aircraft visible, real time, to air traffic control (ATC) and to other appropriately equipped ADS-B aircraft.

According to the European mandate 1207/2011 (incl. amendments by 1028/2014) all aircraft with a maximum certified take-off mass exceeding 5,700 kg or having a maximum cruising true airspeed capability greater than 250 knots have to be equipped with Mode S ES ADS-B until 2020. General Aviation (GA) aircraft in Europe are not affected by this mandate; an extension of the current mandate is being discussed with unclear outcome. Some countries in Europe have already mandated carrying Mode S transponders while flying within their airspace of responsibility. Amongst other benefits this also enables TCAS equipped aircraft to identify these airspace users when the aircraft is in close proximity as intruders. Thus, ADS-B In/Out also bears benefits for GA as they would be integrated in the same surveillance and safety layer as commercial aircraft. The equipage and operation of GA aircraft with Mode S ES ADS-B transceiver in Europe will significantly increase the safety level in European airspace.

This development is intended to encourage GA to install and use "ADS-B Out" and "ADS B In" by providing new services. The proposed solution will avoid the installation of a cost intensive second and third layer of ADS-B ground infrastructure (i.e. UAT and ADS-R) by Air Navigation Service Providers (ANSPs) in Europe as they have in US whilst increasing the safety level and reducing effort and costs of Flight Information Services. Thus, supporting operational performance and safety whilst providing a benefit to cost effectiveness of the ANSPs’ ground infrastructure.

This activity foresees two possible solutions dependent on the operational environment to be deployed in:

1. **Delivery of TIS-B and FIS-B for GA via existing infrastructure** (ADS-B ground stations and WAM /MLAT systems) to either existing SSR transponders or ADS-B In devices on-board the aircraft. However, in order to provide additional services like FIS-B the 1090 MHz frequency seems to be not always the optimal choice, because of the required bandwidth of these services on the one hand and dependent on the amount of traffic causing limited capacity of the Mode S ES radio frequency on the other hand. For those areas where neither the 1030MHz nor the 1090MHz Data link would achieve the required performance due to spectrum congestion the following solution (#2) is proposed.

2. **Delivery of new services similar to FIS-B for GA via** a different, already existing and modern communication infrastructure, namely **cellular mobile telephony**. Data transfer standards like UMTS and LTE could provide sufficient bandwidth to enable the on-board display of e.g. graphical weather data and information on the utilization of restricted airspace. The ground infrastructure provides the data to the user via website access. The on-board solution could be APP-based on devices like smartphones or tablet computers. An expensive integrated display is not necessary and reliefs aircraft owners of additional costs whilst ensuring a safe operational environment to GA, commercial aircraft and ATC.

Activities to be done

- Integrated COM and SUR spectrum assessment to obtain maximum bandwidth available to the service.
- Assessment of telecommunication coverage, bandwidth availability and data integrity.
- Verification, validation and flight trails to assess the above mentioned activities.
- Software development of application.
- Development of ConOps.
- Definition for a common communication interface.

Level of Maturity

No baseline available / allocated. New activity / solution.

V1, V2 and V3 activities to be performed

Expected outcomes (and deliverables)

Feasibility study is available for both communication methods (1030 MHz and GSM/3G/4G).

Concept of operations is available for both methods.

Prototypes are available (ground equipment as well as airborne equipment) and have been demonstrated during validation trials.

Assessment of benefits and drawbacks comparing the two methods.

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

Dependencies with external activities:

PJ.14 activities have, in principle, dependencies with external standardization activities & organism, such as:

- FAA NextGen Surveillance Broadcast Service (SBS)
- ICAO, for international standardisation
- EUROCAE WG 100 developing specifications for Remote & Virtual Tower.
- SPI IR 1207/2011 - surveillance performance and interoperability implementing rule
- Coordination with Work Program of the ICAO Communications Panel (CP), the Air surveillance Panel (ASP) and the Navigation Systems Panel (NSP)
- Coordination with standards activities performed within ICAO, RTCA, and EUROCAE

Validation of the Solution

This solution needs validation activities for the prototypes.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SESAR Solution PJ.14-02-06: Completion of AeroMACS development

Solution Description

AeroMACS is one of the three new FCI data links (the others being the future terrestrial – LDACS and the future SATCOM) and its implementation will provide efficient and high bandwidth communication capabilities for critical communications in the airport surface using spectrum allocated to aviation only and supporting mobile and fixed users.

The strategic importance of AeroMACS for aviation covers the use of the spectrum of the C band by aviation and supports the integration of the critical communications (safety and regularity of flight) of all 3 stakeholders in the airport environment: Airlines, ANSPs and Airport Authorities.

In addition, the EASA data link report on the VDL2 issues specifically identifies AeroMACS as a potential solution to the frequency congestion problems already occurring in the airport environment and calls to consider AeroMACS to offload the VDL2 channel(s) at the airport environment.

SESAR1 (Projects P9.16 and P15.2.7) have undertaken extensive activities involving analysis, prototyping and testing and supported (and continue to support) the ongoing standardisation of AeroMACS in EUROCAE/RTCA, ICAO, WiMAX Forum and AEEC. With the contribution of SESAR1, there are already ICAO SARPs, EUROCAE/RTCA Profile and MOPS. In addition MASPS are being finalised by EUROCAE and AEEC is working on an ARINC aviation standard.

Nevertheless at the end of the testing of AeroMACS in SESAR1, some specific activities have been identified that need further investigations to ensure that all potential issues are addressed and resolved in advance of implementation activities. The identified issues concern the connectivity of AeroMACS in the ground airport network infrastructure and involve also the security aspects and the interoperability among different manufacturers. In addition, AeroMACS airborne architecture integration aspects need to be addressed in particular for the short and medium term scenarios (in the absence of an ATN/IPS infrastructure) in coordination with the AEEC AeroMACS activities.

While in particular the security issue are not expected to be specific to AeroMACS (and also the FCI data links in solutions 1, 2 and 3 are concerned), AeroMACS is the first link that is addressing these integration issues in particular in the ATN/IPS context.

Therefore, the scope of the solution is to:

- To complete validation of AeroMACS with trial deployment(s) at airport(s) with multiple mobile users at the same time integrating AeroMACS on vehicles and EFB equipped aircraft.
- To support validation of other potential usages of the AeroMACS data link to support especially (VoIP) digital voice communication and multilink.
- To prepare/support the consideration of the AeroMACS enabler in VLD(s) demonstrating the

AeroMACS capabilities with involving airport(s) and Airlines

Activities to be done

Indicative activities for AeroMACS include testing of the technology and in particular of the ground connectivity aspects (network, security etc.) and trials with digital voice. In addition QoS related configuration should be investigated and integration with other solutions (PJ.03 - integrated surface management, safety nets), e.g. proper vehicle integration of terminal with other technology, representative pilot deployment.

Furthermore, the following topics shall be covered:

    - Definition and standardization of Network and Security requirements (e.g. Certificate Profile definition, with agreement on Certification Authority, definition of Ground Network Protocols, etc.)
    - Integration of ATN over AeroMACS within ANSP domain for ATC services
    - Review and finalization of a digital voice communication solution over AeroMACS (VoIP).
    - Multicast/Broadcast (MBS) Algorithms definition.
    - AeroMACS integration on board the a/c
    - Consider the support of using AeroMACS to offload VDL2 channels in busy airports
    - Potential evolution of AeroMACS specifications in line with the evolution consideration in the WiMAX Forum for the WiMAX standard.
- Identification/specification of multilink requirements for the AeroMACS A/G data links supporting ATN/IP.
    - Definition and potential implementation of Technology Handover (i.e. Handover from AeroMACS to VDL2/SBB during take-off, and vice-versa during landing)
    - In coordination with COM solution of 5, review of (cyber-) security (e.g. confidentiality, availability, trustworthiness) and data integrity aspects. Authentication and air interface encryption are expected to be required, and need to be dealt with in a federated “system of CA/Public Key Infrastructures” that shall be able to create, update and revoke certificates available and trustable among all the stakeholders.

Level of Maturity

SESAR 1 defined LDACS, AeroMACS and Satcom basic functionality but the availability of a Data link solution requires to study, define, implement and test the following items:

- Data link selection criteria and capability, based on the information sent by the ground system and the “status” of the aircraft;
- Data link capability to integrate heterogeneous ground networks and functionality, e.g. multiple CSP, non-ATM functionality (e.g. ACARS)
- Data link capability to integrate the Air-Ground SWIM in all flight phases;
- Data link capability to establish and maintain a “security context” across several Data links used during all the flight phase

For AeroMACS there is some work from past activities in particular P9.16 and P15.2.7, so PJ.14 activities will continue the work carried in P9.16 and P15.2.7:

- SESAR 1 P15.02.07 D04 to D08; D10 and D11
- SESAR 1 P9.16 deliverables

Expected outcomes (and deliverables)

AeroMACS security concept, ground network connectivity, ground and airborne integration of AeroMACS over ATN (IPS and potentially OSI for short term benefits), interoperability testing among different manufacturers (using prototypes developed in SESAR1), validation of using digital voice over AeroMACS.

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

Validation of the Solution

The validation Solution foresees a common platform in order to implement the following tests:

- Integration with ATN-IPS and SWIM nodes;
- Support of security and PKI infrastructures;
- AeroMACS integration with ground networks;
- AeroMACS integration on vehicles;
- AeroMACS integration on EFB equipped Aircraft;
- AeroMACS/VDL2 Handover.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-02-06 Completion of AeroMACS development		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
OI Step and Title						
Enabler	**Enabler Title**					
CTE-C02d	New Airport Data link technology (AEROMACS): - New wireless technology for the Airport Data link AEROMACS over ATN/IPS, based on IEEE 802.16 WiMAX, as a new standard for airport surface communications (ATS, AOC and APOC) for the Aircraft and Vehicles	V3 on going	V3			
CTE-C01b	New Digital Voice	N/A			V2	V3

SESAR Solution(s) PJ.14 Navigations

Navigation is a key enabler for supporting SESAR programme to increase capacity, improve efficiency, reduce environmental impact, and improve access to airports, in order to meet the performance targets and operational needs developed in SESAR2020 as well as to achieve global interoperability.

Identifying specific requirement regarding Navigation systems arising from SESAR2020 shall be addressed achieving appropriate horizontal and vertical navigation performance, in normal or abnormal conditions, in particular in terms of accuracy and integrity and functional capability, for a given environment (surface, approach, TMA, en-route), with global traffic characteristics (including Mainline, Regional, BA, GA, rotorcraft and military) under an agreed and validated operational concept.

This project will define the role of GNSS (GNSS Dual frequency Multi constellation, SBAS Dual frequency multi constellation and GBAS) as the main navigation infrastructure in the new SESAR baseline and mature its standardization as well as its back up (Alternative-Position, Navigation and Timing (A-PNT)), and act as a transversal and federating project for all operational projects.

The overall goal of the project will be to ensure that key benefits from evolving technologies are brought to the SESAR baseline.

For the Navigation domain solutions proposed are:

- SESAR Solution PJ.14-03-01: GBAS;
- SESAR Solution PJ.14-03-02: Multi Constellation / Multi Frequency (MC/MF) GNSS;
- SESAR Solution PJ.14-03-04: Alternative Position, Navigation and Timing (A-PNT).

SESAR Solution PJ.14-03-01: GBAS

Solution Description

GBAS is a satellite-based system using local augmentation to support precision approach operations. It enables improved operations under low visibility conditions also at airports not equipped with ILS. Furthermore in comparison to ILS it allows higher flexibility in procedure design, for example curved approaches and new approach procedures with less fuel consumption and environmental impact. Industrialisation overlaps with deployment phase.

The benefits include raising the capacity at high-density airports and enabling better protection against aircraft generated noise for the population in the vicinity of airports, by using advanced procedures, parallel independent operations and low visibility operations.

GBAS CAT III L1 (GAST D) Extended scope: ensures the early availability of GNSS based LVP operations and implementation of advanced procedures. This first generation GBAS CAT II/III solution within the scope of SESAR1 will provide the service necessary to conduct LVP at least in mid-latitudes. The objective for SESAR 2020 is the conclusive development of GBAS CAT III L1 (GAST D) to enable benefits from the advantages and the potential of the GBAS technology that is already in use down to CAT I operational / weather conditions, down to CAT II/III minima. Also to finalize standardization, fill the regulatory gaps between the current maturity level and industrialisation phase for the ground and airworthiness regulatory framework, and also do further performance evaluation if needed. The single frequency solution GBAS CAT III solution will also represent a legacy and fall-back mode for MC/MF GBAS and therefore GBAS GAST F operation should be consistent with GBAS GAST D.

GBAS Cat II/III (GAST F) based on MC/MF GNSS (GPS + GALILEO / L1 +E1 + L5/E5) enables also Cat II/III operations based on GNSS. Multi-Constellation Multi-Frequency improves integrity, accuracy, continuity of service and availability compared to GBAS GAST D positioning. This will allow for more robust operations, especially at high and low latitudes with tougher ionospheric conditions and with regard to unintentional RFI.

Civil-Military interoperability/equivalence between PALS and GBAS in relation with the military plans on precision approach and landing systems (PALS) as defined by NATO (not to confuse with the US JPALS programme).

The civil-military GBAS interoperability is based on the current baseline, which specifies a dual system, based on a civil system (GBAS) together with a military system, both at ground and airborne levels. The main rationale of this approach is to support the emergency and humanitarian missions in parallel to the military flights, and the landing of the military aircrafts in civilian airports using GBAS civil signals broadcast from ground. Therefore, the dual system involves the installation of GBAS technology on-board of military aircrafts. In addition to this, it should be noticed that a dual system is a key tool towards the single sky concept. At performance level, it is to be pointed out that a military system fulfils CAT I as defined by ICAO.

Activities to be done

GBAS (elicitation of requirements and demonstrating feasibility to support advanced procedure, targeting CAT II/III operations and ground subsystem prototype development and implementation) for L1 and in a multi-frequency multi constellation GNSS environment.

GAST D Extended scope: In order to take benefit of the investments made in SESAR1, further activities related to GBAS CAT II/III L1 are necessary. These include trade-off assessments and improvement implementation for low and high latitude regions and demanding environments, in parallel to the publication and establishment of the relevant standards and regulations. The activities include preparations for Ground Station approval in Europe. Additionally the GBAS support for transition to the final segment is to be covered (Dmax extension and extended service volume also requested by Solution PJ.02-11 Enhanced Terminal Area for efficient curved operation) in support of GBAS (CAT III) advanced operations. The activity includes the installation of extended prototypes (including airborne) compared to prototypes developed in SESAR 1.

Based on the results of the current SESAR program, the following activities are essential for the further development of GBAS CAT II/III L1 (GAST D):

- Validation of GAST-D ground station in new scenarios, for further contribution to the operational validation (e.g. ion conditions at lower and higher latitudes) including the GAST D extensions for large airports with complex layout and busy environment, further assessment and Extended service volume considerations. The technical work related to the extended service volume, which is an important enabler for PJ.02 activities, is foreseen to be conducted here.
- Perform verification and validation of performance, including measurement equipment for ground & flight-testing.
- Interface with PJ.02 and VLD 1-5/2-5 projects on the technical aspects of GBAS GAST D operational implementation. This activity includes adaptation of operational concept and operational safety case for GBAS CAT II/III L1 implementation at airports to take new environments into account, and to include aspects related to extended service volume. This will result in ATC and maintenance interfaces, and technical work related to criteria and approach procedures for GBAS CAT II/III L1, Adaptation of airfield Low Visibility Procedures within a GBAS CAT-III operation (establish benefits from the demise of the ILS critical areas)
- Further establish European rulemaking and regulatory framework for GBAS CAT III L1 ground stations. This includes preparations for GAST D ground station approval for Europe and airborne equipment.

- Proceed with standardization: Ground & airborne (if required) MOPS, ICAO Doc 8071 Vol. II update for GBAS CAT III L1.

GAST F: MC/MF CAT II/III GBAS robustness is improved by using MC/MF GNSS satellite signals. The activity is a continuation of initial technical developments started in SESAR 1. The continuation starts with an updated feasibility and trade-off analysis and refinement of GAST F requirements based on the outputs from 15.3.7, and continues with the development of GBAS MC/MF airborne and ground segment components and integration to initial Prototypes including implementation into the operational environment and operational validation. Activities include:

- Updated feasibility and trade-off analysis for MC/MF GBAS, based on 15.3.7 outputs
- Definition of MC/MF GBAS Prototype System with respect to refinement of GAST F requirements, covering: consolidation of the research activities, mainly on the aspects not covered in SESAR-1 (i.e. new topics on the new constellations and frequencies, like fault modes)
- System definition and specs, safety assessment, installation and siting
- Definition of Ground MC/MF components (Receivers/Antennas),
- Definition of Airborne MC/MF GBAS receiver (continuation of SESAR work in WP9.12/WP15.3.7),
- Definition and Development of ground and airborne prototypes
- Data Collection and Performance assessment
- Cost Benefit analysis
- Integration, verification and validation in operational environment (Ground & Flight trials)
- Identification of operational issues compared with GAST D SESAR 1 solution.
- GBAS airborne architecture definition for non-mainline GAST-C/GAST-D/GAST-F operations (enabling Bizjets or regional aviation, general aviation and helicopters to perform GLS operations without MMR).
- Definition of GBAS CAT II specific solution (continuation from SESAR 1), especially for Bizjets or regional, and general aviation. Verification of the concept.
- Progressing GAST F standardization. Consolidation of the standards and verification by prototyping and/or flight trials. Liaison with regulatory bodies (EASA).
- Preliminary cost assessment (assuming the benefit assessment is done in an operational package – coordination with operational package)
- Ensure backward compatibility of system architecture with GAST D/C.

Civil-Military GBAS interoperability

- Investigation of potential use of multi-frequency / multi-constellation solutions for civil GBAS on the NATO PALS transition strategy.
- Compatibility of civil GBAS with PALS that would increase GNSS robustness against interference of the type Jammer/Spoofer; Topics to be studied:
    - Digital Beam Forming (DBF) using antenna array processing to concentrate the maximum gain in the satellite direction and minimize the gain in the direction of potential jammer or spoofer; (concentrating on effect of compatibility when using civil GBAS ground transmissions)
    - Use of PRS for GALILEO constellation in place of “Safety of Life” service level and/or encrypted GPS signals (concentrating on VDB bandwidth and compatibility with civil signals) (According to our last news, Galileo PRS will be considered in the future NATO PALS system in the military part. However, Galileo PRS would increase the security level of the documentation and the team to RESTRICTED. It is therefore TBC whether PRS can be addressed within the scope of SESAR2020).
- Further, analyse interoperability aspects, like operations concept and flight procedures, the

integration into the single sky concept and the data link ground-air.

- Analysis of the enablers devoted to the common airspace management and in particular MIL-STD-01, MILT-STD-02 and A/C-56a.
- Analyse security issues derived from installing PALS technology in civil airports or in dual airports.

Level of Maturity

GAST D: For the activities covered in SESAR 1 15.3.6/ 9.12 the level of maturity expected to be achieved is V3. For the additional activities defined in SESAR 2020, the expected level of maturity within SESAR 2020 is V3. The additional technical activities identified in PJ.14 are enablers that are important for the operational activities in PJ.02 and VLD 1-5/2-5. The extended service volume aspect is particularly important for PJ.02. The regulatory work is particularly important for the VLD activities.

GAST F: While some components may be in V3, integrated ground and airborne segments are seen in V2. The maturity level of the integrated GBAS GAST F ground and airborne segments is dependent on the maturity of the GNSS signal and constellation extensions (availability ranging sources providing of E1 and E5/L5 frequencies) and the maturity of standards.

Civil/Military Interoperability: Military aspects are already being studied, and are mostly mature, but independently from civil developments. Interoperability aspects need to be addressed at all levels and the effect on civil GBAS is currently unknown.

Expected outcomes (and deliverables)

GAST D: Final Prototypes supporting large and complex airport and with expanded suitability for low/high latitudes and transition to final segment. Inputs to standards and regulation for system level, air and ground components. Solutions for the extended service volume concept. Concept, specification and prototype ATC interface.

GAST F: Subsystem component prototypes and early Ground and airborne segment prototypes (Del: Availability note). Inputs to standards and regulation as well as evidences derived from any potential flight trials in order to support the standard validation up to a certain extent. In particular, relevant inputs shall be provided to

- ICAO/NSP working groups, mainly CSG
- EUROCAE WG28, 62
- RTCA SC159

Civil/Military: (Del: Availability note), Assessment of interoperability aspects and inputs to regulation. No dual system prototype is expected to be delivered neither at ground nor airborne level. A Technical Note is expected to be delivered.

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

GAST D (L1):

- The prototypes support VLD Wave 1 and 2 (VLD 1-5 & 2-5)
  - Standardisation & Regulatory aspects (incl. ICAO, EUROCAE, RTCA support and EASA, NSA coordination)

In general, where there are links to operational packages, the technical work is expected to be carried out in PJ.14, whereas operational activities will take place in PJ.02 (and VLD). Whereas PJ.02 and VLD 1-5/2-5 are focussed on flight procedures, airspace design and runway throughput, PJ.14 concentrates on the infrastructure.

GAST F (MC/MF):

- Support of VLD wave 2 is expected (VLD 2-5).
- Coordination with standards activities performed within ICAO, RTCA, EUROCAE
- Liaison with EASA.

GBAS Civil/Military: This topic is linked to PJ.08 – Advanced Airspace Management. NATO short-term plans are to define the standards on PALS.

Validation of the Solution

GAST D: Verification and validation in demanding environment (low/high latitudes) envisaged. Prototypes can support the demonstration of advanced CAT III operations. Validation on a theoretical level to assess compliance to emerging regulation framework.

GAST F: Verification and validation MC/MF CAT II/III GBAS.

GBAS Civil/Military: Validation will be by analysis of impact on civil GBAS standards and description of limitations of military PALS performance when broadcasting civil GBAS corrections from ground. Verification and validation limited to theoretical analysis. No flight test is proposed.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-03-01 **GBAS**		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
OI Step and Title						
Enabler	Enabler Title					
CTE-N07b	GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)	V3				V3[1]
CTE-N07c	GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)	Early V2				V2[2]

[1] V3 was achieved in SESAR1 for the activities included. The additional activities included in this

extended scope, are planned to meet V3 by the end of SESAR 2020.

2) The level of maturity is linked to the maturity of the core constellations used (GPS and Galileo). Full Operational Capability for the new frequencies and constellation is to be confirmed.

The Single frequency solution is linked to the following existing enablers in DS13:

- CTE-N07 Ground Based Augmentation System (GBAS)
- CTE-N07b GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)
- A/C-56a Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1
- BTNAV-0301a, BTNAV-STD-08 Update of ICAO Annex 10 for initial GBAS Cat II/III on GPS L1
- CTE-XX GBAS Extended Service Volume
- REG-0011 AMC for Initial GBAS Cat II/III
- PRO-069dATC Approach Procedures using GNSS / GBAS
- PRO-AC-56a Cockpit Procedure for GBAS CAT II/III

The MC/MF solution is linked to the following existing enablers in DS13

- CTE-N07 Ground Based Augmentation System (GBAS)
- CTE-N07b GBAS Cat II/III based on Single-Constellation / Single-Frequency GNSS (GPS L1)
- CTE-N07c GBAS Cat II/III based on Multi-Constellation / Multi-Frequency (MCMF) GNSS (GPS + GALILEO / L1 + L5)
- A/C-56b Flight management and guidance to support GBAS CATII/III using dual GNSS
- CTE-N4c GBAS Cat 2-3 universal, Galileo and GPS L5 based
- PRO-069dATC Approach Procedures using GNSS / GBAS
- PRO-AC-56a Cockpit Procedure for GBAS CAT II/III
- BTNAV-STD-03 : Galileo service and antenna
- BTNAV-STD-04 : Galileo Open Service in ICAO provisions
- CTE-N05 : GNSS performance assessment system

The GBAS Civil-Military Interoperability solution is linked to the following existing enablers in DS13:

- A/C-56a: “Flight management and guidance for Precision Approach GBAS CATII/III using GPS L1: - : - Flight management and guidance for Initial Precision Approach GBAS CATII/III using e.g. GPS L1 or equivalent military system (e.g. GPS encrypted signal)
- MIL-STD-01 - Trajectory management and improved navigation: - Detailed supplementary specifications under ICAO PBN framework to support specific performance based elements required for military NAV systems (TACAN, GPS/PPS, Galileo/PRS, INS, MMS)
- MIL-STD-02 - Vertical navigation for fighter aircraft: - Means of compliance for military fighter aircraft systems for compliance with vertical navigation requirements

GBAS supports the following Operational Improvements

- AO-0502 Improved Operations in Low Visibility Conditions
- AO-0505-A Improve Low Visibility Operation using GBAS Cat II/III based on GPS L1
- AOM-0605 Enhanced terminal operations with automatic RNP transition to ILS/GLS/LPV
- AOM-0701 Continuous Descent Approach (CDA)
- SPC01.01 Improved Operations in Low Visibility Conditions
- AO-0311 Reduced low visibility CAT II & III arrival separations
- AO-0319 Enhanced Arrival procedures using multiple Runway Aiming Points
- AO-0320 Enhanced Arrival procedures using Increased Glide Slope (IGS)

SESAR Solution PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS/SBAS

Solution Description

Standardization developments for multi-constellation GNSS receivers have so far focused on the use of GPS and Galileo in the L1 / E1 and L5 / E5a frequency bands. This includes SBAS (WAAS and EGNOS). However, due to global developments it will be necessary to also consider the possibility to integrate core constellations such as GLONASS and BeiDou as well as additional SBAS systems. This presents a number of significant interoperability challenges in terms of antenna front end design, out of band rejection characteristics, and receiver architectures and algorithms. The consideration of GLONASS and BeiDou in addition to the current GPS/Galileo baseline (which is the working hypothesis of EUROCAE WG62) has a significant dependence on the evolution of those core constellation services and the availability of associated documentation. If GLONASS and BeiDou will migrate towards a fully GPS/Galileo compatible solution using CDMA signals in the L1/E1 and L5/E5a frequency bands, then the project may advance much more in working towards initial receiver prototypes that are capable of handling all core constellation signals. If however, the future implementation of GLONASS and BeiDou would require the consideration of multiple signal structures such as FDMA in additional frequency bands, then the work will focus more on identifying technical challenges and assessing potential solutions to these challenges in terms of achievable benefits and cost trade-offs.

The reception and processing of satellite signals on two different frequencies enables the correction of ionosphere delays, and improves the accuracy of the navigation solution. In addition, fall-back modes using one of the two frequencies will improve the robustness and reliability of the system in case of interference or high ionosphere activity. The additional satellites provided by the new constellation(s) will also improve the accuracy, integrity, continuity and availability of the navigation solution. The multi-constellation integrity concept is still under study in a common U.S. – Europe working group (conclusions expected in 2015), but the future Multi-constellation RAIM (for Advanced Receiver Autonomous Integrity Monitoring) airborne algorithm aims at providing horizontal and vertical guidance for LPV200 approaches.

The operational improvements linked to MCMF GNSS/SBAS still remain to be defined however it is foreseen to support PBN, Approaches with horizontal and vertical guidance, ADS-B and 4D concepts and allow for ground infrastructure rationalization.

SBAS (Space Based Augmentation system) is a system that provides GPS augmentation by broadcasting correction, geo ranging and integrity data for the GPS satellites through an additional geostationary satellite. The current implementation of SBAS is based on the GPS L1 signal only, and the work in this project will focus on developing an MCMF SBAS capability.

SBAS currently enables approaches down to 200ft minima landing capability on non ILS CAT I-equipped runway (LPV approaches). The same operational performance target is envisaged for MCMF SBAS and Multi-constellation RAIM. Additionally, more demanding performance targets are being discussed for both systems.

The on-going upgrade of SBAS aiming at broadcasting correction and integrity data for multiple constellations on several frequencies will bring new capabilities. The increasing number of SBAS systems (WAAS, EGNOS, MSAS, GAGAN,) will also improve SBAS coverage.

Emerging concepts to improve runway occupancy and traffic throughput (like Adaptive Runway Aiming Point - ARAP -, Adaptive Increased Glide Slope - AIGS - or RNP to GLS) currently only consider GBAS as an enabler. However MCMF SBAS or Multi-constellation RAIM could also be considered for such applications. Concepts such as curved SBAS, AIGS/SBAS or ARAP/SBAS, which will be studied in PJ.02-02, could be enhanced with better performance provided by MCMF SBAS.

Moreover the modernisation of SBAS and Multi-constellation RAIM could also enable autoland capability or lower minima SVGS operations. New operations such as LPV100 need deeper study in light of the improved capability that will be brought by MCMF SBAS.

Because of low power levels of GNSS signals, the satellite navigation receivers are intrinsically susceptible to interference including - non intentional or even intentional –jamming threats. Aforementioned disturbances have already occurred and may impact aeronautical navigation services based on GNSS and its augmented derivatives.

In the context of a wider reliance on GNSS based data in C.N.S., with increasingly stringent performance requirements to provide gate to gate operations and services, it is necessary to ensure that GNSS based solutions have adequate and sufficient robustness.

The introduction of future multi-frequency multi-constellation aeronautical GNSS receivers constitutes an opportunity to enhance resilience against interference, jamming and spoofing.

This is to be studied by considering interference scenarios to civilians defined and framed with inputs from external projects and/or bodies, identifying criteria of success making resilience solutions cost-beneficial, that is to say efforts and complexity to implement robustness techniques cover most of the threats scenarios with a sufficient degree of efficiency and at a reasonable cost of design, manufacture and certification costs, without export control limitations.

Finally, the robust solution cannot be limited solely to a solution based on a GNSS receiver evolution but rather be studied in the overall context of utilization assuming all available barriers (e.g.; aircraft architectures using other sensors such as inertial systems, A-PNT (e.g. DME), law enforcement measures, regulations and state policies).

Activities to be done

- Definition of the MCMF GNSS/SBAS receiver and concept of operation will include :
    - Constellation performance
    - Mandates management and fall-back modes
    - Relationship with PBN
- Supporting standardisation activities led by RTCA and EUROCAE
- Liaising with EASA
- Operational improvement
- Integrity schemes (Multi-constellation RAIM, SBAS)
- Consolidation of requirements (in cooperation with operational package, e.g. PJ.02)
- Assessment of trade-off between benefits and complexity to add constellations and frequencies in hybridization with INS
- Prototyping MCMF GNSS/SBAS
- Receiver prototype integration (e.g. MMR)
- Development of a robust navigation solution including but not necessary limited to, using a MCMF GNSS/SBAS receiver providing resilience to interference, jamming and spoofing considering innovative solutions (e.g. use of techniques for interference and spoofing mitigation available for civil applications). The navigation solution architecture resilient to jamming and/or spoofing should consider aircraft architecture relying on other sensors such as inertial systems and A-PNT.
- Performing flight tests (MCMF positioning data collection)

Additional operations could be enabled by the receiver, such as LPV 100 and further supporting technical analysis (Navigation System Performance and requirements analysis, task in 14-01-01).The concept of operation, which will have a direct impact on the receiver architecture and capability, will be defined in this solution.

Support towards the development of standards (e.g. MOPS) and regulatory framework of the MCMF concept within the standardisation and certification bodies will also be performed.

The integration of MCMF receiver within existing avionics is also of interest and should be clarified. In particular, new integrity schemes require up-to-date information on satellites and constellations reliability: the dissemination of the ISM (Integrity Support Message) for Multi-constellation RAIM is still under study and could impact MCMF receivers and other equipment.

Level of Maturity

Solution PJ.14-03-02 activities will continue work from project 9.27 Multi-constellation GNSS Airborne Navigation Systems. At the end of that SESAR 1 project, the MCMF GNSS receiver will have achieved a significant maturity level with regards to technological issues. However the actual definition of the receiver (constellations, frequencies, channel number, satellite and mandate management) is still to be clarified based on the concept of operation. It is expected that the maturity level at the end of SESAR 1 will have reached V2.

SBAS single constellation / single frequency are a mature technology. SBAS modernisation is planned in the coming years. Although a preliminary ICD of SBAS L5 signal exists, no concept of operation is attached to it for the moment. Moreover compatibility between multiple SBAS system is not clearly addressed in the current standards and also faces political issues linked to future mandates. SESAR 1 has not addressed SBAS signal modernisation topics focusing on MCMF receiver issues.

Some studies on MCMF GNSS receiver have already been performed within the frame of SESAR 1 aimed at the definition of standard receiver architectures. Initial studies on the impact of jamming and spoofing, on the performance measures for standard receivers have been performed. However, no solutions are available for reliably countering aforementioned threats in order to ensure performance, especially in the context of MCMF GNSS services.

Maturity level V3 can be reached at the end of SESAR 2020 on receiver level for interference, jamming and spoofing detection methods and mitigation methods. These methods can be implemented in a receiver mock-up or prototype and validated by field experiments and laboratory tests.

Considering integration of the robustness into the whole ATM system by involving A/C architecture and ground detection, system maturity level V2 may be achieved.

The maturity of MCMF GNSS based on Multi-constellation RAIM is expected to reach V3 for horizontal guidance aspects by the end of SESAR 2020 project. Vertical guidance aspects, which may require the use of an Integrity Support Message, are only in the initial architecture design stages and are not likely to reach more than V1 in the same timeframe.

The maturity of MCMF GNSS/SBAS is expected to reach V2 by the end of SESAR 2020 project.

Expected outcomes (and deliverables)

A concept of operation document for MCMF GNSS/SBAS is expected.

A clarification of MCMF receiver capability will be available based on preliminary performances of GPS L5 and Galileo constellations.

A technical concept for future MCMF GNSS/SBAS receiver will be developed.

A receiver prototyping activity is also foreseen to assess feasibility and performances of future MCMFGNSS/SBAS receivers with enhanced robustness against jamming and spoofing.

Results of the practical assessment and validation of a navigation solution using various independent sensors from GNSS and the receiver performance by laboratory tests and field experiments will be documented.

Requirements toward robust ground and on-board architectures, using independent sensors from GNSS such as inertial systems and GNSS receivers for aviation use with respect to the RFI robustness including jamming and spoofing will be technically analysed and assessed.

Architectures of robust ground and on-board architectures, using independent sensors from GNSS such as inertial systems and GNSS receivers with the detailed description of the corresponding signal processing techniques and hardware solutions will be proposed.

An assessment of trade-off between benefits and complexity to add constellations and frequencies in hybridization with INS will be carried-out

Major links and dependencies

Strong support to standardisation activities in RTCA and EUROCAE is foreseen to prepare deployment of MCMF receivers as soon as FOC (Full Operational Capability) is announced for GPS L5 capability and Galileo.

The ConOps and the specifications of MCMF GNSS/SBAS receivers will be used to sustain the standardisation activities in EUROCAE and RTCA forums:

- EUROCAE WG-28 / Global Navigation Satellite System (GNSS)
- EUROCAE WG-62 / Galileo
- Coordination with RTCA, EASA

Links to PJs implementing future concepts is provided in the dependency table.

Links to SESAR 1 implementing future concepts:

- Project 9.27: Multi-constellation GNSS Airborne Navigation Systems
- Project 15.3.4: GNSS Baseline study

Validation of the Solution

Flight tests will be required to validate some of the concepts that will be supported by new MCMF GNSS/SBAS signals. They will also help to characterise error models for the new signals (e.g. Signal-in-space, multipath) and assess their performance.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-03-02 **Multi Constellation / Multi Frequency (MC/MF) GNSS/SBAS**		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
A/C-02b	Enhanced positioning using multi constellation GNSS dual frequency					V3
CTE-N01	GPS L1/L5					V3
CTE-N02	GALILEO E1/E5					V3
CTE-N03	GLONASS-K					V2
CTE-N04	BEIDOU B1/B5					V2
CTE-N05	GNSS performance assessment system					V3
CTE-N06	Space Based Augmentation System (SBAS)					V3
CTE-N06b	EGNOS V3					V3
A/C xxxx	Aircraft capability to support MCMF SBAS Cat II			V1		V3

NOTE : the list of enablers will be further updated in the frame of DS15.

Those enablers support: AO-0505-B, AOM-0304-B, AUO-0613, CNS-0002-A, CNS-0002-B & CNS-0002-C

SESAR Solution PJ.14-03-04: Alternative Position, Navigation and Timing (A-PNT)

Solution Description

Alternative-Position, Navigation and Timing (A-PNT) is a technological enabler related with the need to introduce ground and airborne systems that can support currently defined and standardized PBN and other CNS-based operations and provide a backup with similar level of performance in case of corruption, degradation and absence/loss of GNSS.

A-PNT could be implemented through enhancing existing technologies (DME, IRS hybridization), new technologies (Multilateration, LDACS, Mode N, etc.) or their combinations.

This enabler supports ATM solutions under development in PJ.01 “Enhanced Arrivals and Departures” for its most demanding performance requirements but also all PBN operations in general except final approach.

The solution shall fulfil the following high level objectives:

- It shall address the A-PNT system as whole i.e. including the ground and the airborne equipment (Avionics / FMS and ground infrastructure) and address all CNS needs.

- It shall enable the deployment of new systems or applications within the congested L-band with the APN-T solution using less spectrum than legacy systems though retaining legacy functionality thus furthering a smart rationalization strategy.
- It shall assess the trade-off between the technological improvement feasibility and the obtainable NAV performance improvement by performing an analysis based on an optimisation of the ground based NAV system configuration and the evaluation of the impacts of additional airborne installations/upgrades
- It shall assess trade-off between benefits and complexity to add A-PNT technologies in INS hybridization for all phases of flight
- It shall address the implementation paths scenarios considering the need of ensuring backward compatibility with existing legacy technologies, while, when considering new technologies, having significantly better performance and spectrum efficiency.
- It shall assess any civil-military interoperability navigation issue by assuring a complete consistency
- It shall be defined in agreement and coordination of similar solutions foreseen outside Europe by ensuring worldwide compatibility
- It shall develop one or multiple solution prototypes, establish the means of and perform the solution verification and validation
- It shall be safety-proven

Activities to be done

The following high level activities are foreseen:

- Definition of requirements for A-PNT for all phases of flight
- Identification and description of short-term feasible technological evolutions of existing legacy systems (e.g., DME, IRS hybridization) and assessment of obtainable navigation performance improvements
- Identification of the addressable RNP/RNAV currently standardized operations that the proposed solution is supporting
- Identification of mid and long-term feasible new technologies (LDACS, mode N, etc.) and detailed description of each candidate solution.
- Identification of feasible new technologies (LDACS, mode N, etc.) and detailed description of each candidate solution.
- Assessment of obtainable navigation performance improvements and identification of the addressable PBN currently standardized operations that the proposed solution is supporting
- Assessment of trade-off between benefits and complexity to add A-PNT technologies in INS hybridization for all phases of flight
- Assessment of the proposed solutions in term civil-military navigation interoperability and worldwide compatibility
- Description of navigation reversion modes
- Analysis of different solutions implementation: ground network optimisation, on-board upgrades, implementation paths scenarios
- Preliminary safety assessment of solution implementation and reversion modes occurrences
- Solution prototypes development and verification/validation execution

Level of Maturity

In SESAR1, A-PNT activities are undertaken in the frame of SESAR project 15.03.02 where an initial work is being performed in close coordination with the 15.03.01 project and project 9.27 involving the airborne part. The project cluster plans to provide a first analysis of the need for Alternate PNT systems and the possible enhancements that could be realisable in the mid- to long- term. The project will investigate also the alternate technology options to support the future PBN environment. No significant technology development will be undertaken by project 15.03.02, but rather, currently on-going activities both by European industry and FAA will be supported and evaluated for operational suitability in greater detail.

Activities will complete V1, and then proceed to V2 and V3.

Expected outcomes (and deliverables)

The project will deliver an A-PNT solution which will be:

- Technically proven as supported by prototype development and verification/validation
- Ready to be deployed and validated in a large scale environment
- Backward compatible with existing technology, interoperable between civil and military navigation, and tentatively worldwide applicable
- Short-term deployable with smooth implementation transition paths
- Mid and Long-term upgradable to support higher standards of performance.
- Supported by a cost-benefit and safety analysis

The project will also identify and described other different A-PNT solutions based on new technologies deployable in longer terms. These solutions will be also compared by a performance and cost-benefit gap analysis.

As results of the overall project it is also expected the production of deliverables whose content could be suitable for updating and evolutions of existing standards.

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

For civil-military interoperability a close collaboration with military institutions are needed.

For global applicability of identified solutions a close coordination with extra-European (i.e. Next-Gen) navigation projects are needed.

Validation of the Solution

The identified solution will be developed at prototype level. As the solution will comprise ground and airborne equipment, verification of single components, their integration and the solution validation at system level will be performed on a common platform and be ready for being deployed in large-scale demonstration

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SOLUTION PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)		**MATURITY**				
		SESAR 1	**SESAR 2020**			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
AOM-0404 Optimised Route Network using Advanced RNP		V1				
CTE-N13a	A-PNT (Alternative Positioning Navigation and Timing)					
CTE-NGOV01	Ground Navaids Optimisation/Rationalisation Plans	V2				
CTE-N08	DME Ground Infrastructure optimisation	V2				
AO-0505-B Improve Low Visibility Operation using GBAS Cat II/III based on dual GNSS		V1				
A/C-02b	Enhanced positioning using multi constellation GNSS dual frequency					

SESAR Solution(s) PJ.14 Surveillance

Surveillance is a key enabler for supporting SESAR programme to increase safety, security, capacity, improve efficiency, reduce environmental impact, and improve access to airports, in order to meet the performance targets and operational needs developed in SESAR2020 as well as to achieve global interoperability.

For the Surveillance domain solutions proposed are:

- SESAR Solution PJ.14-04-01: Surveillance Performance Monitoring;
- SESAR Solution PJ.14-04-03: New use and evolution of Cooperative and Non-Cooperative Surveillance.

SESAR Solution PJ.14-04-01: Surveillance Performance Monitoring

Solution Description

While the global surveillance function in a CNS system needs to be assessed in terms of coverage, accuracy, availability, continuity of service, and reliability, each surveillance system element needs to be acceptance tested not only during commissioning but also in regular intervals in order to validate its operational use. Notably for new surveillance systems (WAM, MSPSR, ICNS, space-based ADS-B) performance assessment methods are still under discussion and need to be conclusively defined due to classical methods and tools are proven to not being adequate.

Eurocontrol is developing a new Surveillance document named GEN-SUR SPR (Generic Surveillance Safety and Performance Requirements) aiming at addressing/encompassing the safety aspects, required by EC regulations and which are not part from the two main relevant Surveillance documents (Standard Document for Radar Surveillance and ESASSP). The goal of this document is also to establish the baseline of the PBS (Performance Based Surveillance) requirements in a similar way to PBN (Performance Based Navigation). The GEN-SUR SPR should also imply revision/update of ESASSPS, ADS-B (ED-129B) and WAM (ED-142A) EUROCAE standards as well as surveillance evaluation tools.

This SPR shall apply to the surveillance chain constituted of:

(a) airborne surveillance systems, their constituents and associated procedures;

(b) ground-based surveillance systems, their constituents and associated procedures;

(c) surveillance data processing systems, their constituents and associated procedures;

(d) ground-to-ground communications systems used for distribution of surveillance data, their constituents and associated procedures

Continuous real-time performance monitoring can identify performance degradation trends early in the process and reduce costs of the regular re-checks.

One particular performance for co-operative surveillance systems is spectrum load created by sensor operation. Methods and tools to monitor 1030 MHz and 1090 MHz spectrum load and to identify the source of this load need to be elaborated.

Activities to be done

- Define detailed methods for WAM performance assessment and justify their benefits
- Define detailed methods for airport MLAT performance assessment and justify their benefits
- Define detailed methods for MSPSR performance assessment and justify their benefits
- Define detailed methods for ICNS performance assessment and justify their benefits
- Define detailed methods for ground- and space-based ADS-B performance assessment and justify their benefits
- Establish the respective sensor (also including communication network performance) performance assessment tools and validate them
- Implement real time performance monitoring in WAM, MSPSR, ICNS and ground- and space-based ADS-B systems
- Define detailed methods for ground-based 1030 and 1090 MHz spectrum load measurement and justify their benefits
- Implement 1030/1090 MHz spectrum monitoring equipment and tools and validate them
- Development/assessment of quasi real-time multi-sensor monitoring tools, including support to standardisation, in accordance with GEN-SUR SPR and ESASSP V2
- Development/assessment of interfacing quasi real-time monitoring tools to ATM systems (interface to ATCO, technical and operational supervisors)

Level of Maturity

As the outcome of this solution will be used transversally throughout the Surveillance parts of PJ.14, the methods and equipment shall represent an industrial maturity level beyond prototyping phase.

Expected outcomes (and deliverables)

Comprehensive description of validated methods to assess performance of WAM, MLAT, ADS-B, ICNS and MSPSR systems.

Validated and documented tools to support performance assessment of WAM, MLAT, ADS-B, ICNS and MSPSR systems.

Validated tools to record and assess 1030 and 1090 MHz spectrum load (limited to civilian signals)

Validated capability for ADS-B, WAM, MLAT, ICNS and MSPSR systems to provide real-time performance monitoring demonstrated using existing prototype systems.

Validated tools for quasi real-time monitoring of the surveillance chain at the SDP output to provide quasi real-time performance monitoring demonstrated using existing prototype systems.

Guidelines for interfacing quasi real-time monitoring tools to ATM systems (interface to ATCO, technical and operational supervisors)

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

PJ.14 activities have, in principle, dependencies with external standardization activities & organism, such as:

- FAA
- ICAO, for international standardisation
- EUROCAE WG51 SG4 developing new versions of ADSB-0106 and new version of GSURV-0113
- EUROCAE WG 41 developing updates of ASMGCS-0113, ASMGCS-0114
- EUROCAE WG 100 developing specifications for Remote & Virtual Tower.
- EU RULE NO. 1207/2011 - SURVEILLANCE PERFORMANCE AND INTEROPERABILITY IMPLEMENTING RULE (SPI IR)
- Coordination with Work Program of the ICAO Communications Panel (CP) and the Navigation Systems Panel (NSP)
- Coordination with standards activities performed within ICAO, RTCA, and EUROCAE

Dependencies with Transversal Projects:

PJ.14 activities have, in principle, dependencies with external standardization activities & organism, such as:

- FAA
- ICAO, for international standardisation
- EUROCAE WG51 SG4 developing composite ADS-B/WAM solutions
- ECTL GEN SUR SPR development WG and ESASSP
- ECTL ARTAS team
- Coordination with standards activities performed within ICAO, RTCA, and EUROCAE
- Coordination with Work Program of the ICAO Aeronautical Surveillance Panel (NSP)

Validation of the Solution

This solution needs validation activities for the prototypes.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SESAR Solution PJ.14-04-01 Surveillance Performance Monitoring		MATURITY				
		SESAR 1	SESAR 2020			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
GSURV-0113	EUROCAE ED142 for 1090ES Wide Area Multilateration specification					
ADSB- 0001	ED 126: Safety Performance and Interoperability Requirements for ADS-B in Non Radar Airspace (ADS-B NRA)					
ADSB-0002	ED-161: Safety Performance and Interoperability Requirements for ADS-B in Radar Airspace (ADS-B RAD)					
ER APP ATC 163	CWP & ground processing systems for ADS-B in Non-Radar Airspace (ADS-B NRA)					
CTE-S02b	Surface Movement Radar	V5				
CTE-S02c	Multi Static Primary Surveillance Radar	V2				
CTE-S02d	Video Surveillance	V5				
CTE-S03a	ADS-B station for NRA surveillance (ED-102)	V5				
CTE-S03b	ADS-B station for RAD and APT surveillance (ED-102A)	V5				
CTE-S03c	New ADS-B station for	V2				

	future ADS-B applications (ED-102A+)					
CTE-S03d	Satellite based ADS-B technology	V2				
CTE-S03e	ADS-B transmitter for vehicles	V5				
CTE-S03f	New ADS-B receiver for vehicles	V5				
CTE-S04a	Wide Area Multilateration (WAM)	V5				
CTE-S04b	Airport Multilateration (MLAT)	V5				
ADSB-0003	ED-163: Safety Performance and Interoperability Requirements for ADS-B for Airport Surface Surveillance (ADS-B APT)					
CNS-0003-A	"Rationalisation of SUR systems/infrastructure for Step1"	V1-V2-V3				
CNS-0003-B	"Rationalisation of SUR systems/infrastructure for Step2"	V1	V2	V3		
CNS-0003-C	"Rationalisation of SUR systems/infrastructure for Step3"		V1	V2	V3	
ADSB-0102a	ED102A ADS-B 1090 MHz Extended Squitter	V5				
ASMGCS-0115	Update of EUROCAE ED128 for A-SMGCS Guidelines for Surveillance Data Fusion					

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SESAR Solution PJ.14-04-03: New use and evolution of Cooperative and Non-Cooperative Surveillance

Solution Description

Cooperative surveillance will become a cost-efficient and dominant part of the future air and ground surveillance for ATM and airport SMGCS purposes. Non-cooperative surveillance systems, however, will remain needed for contingency and security purposes.

Several approaches could be foreseen for non-cooperative surveillance that will lead to new non-cooperative systems :

- Monostatic future non-cooperative surveillance technology
- Multistatic future non-cooperative surveillance technology such as MSPSR.

Furthermore, the introduction of RPAS (low RCS), which could have no cooperative systems, will make use of new non-cooperative surveillance, still more than today.

Major improvements of cooperative and non-cooperative surveillance systems are expected in the following areas:

Composite surveillance

This has to be differentiated from co-located surveillance (e.g. classical co-mounted SSR and PSR). When speaking of composite surveillance, data sharing at sensor level is done between different sensors of different technology, so that more efficient operation is facilitated and spectrum footprint of each system can be reduced in line with the performance goals. The purpose is indeed early initialization of target processing, cross-validation of surveillance data, support in internal processing for the receiving sensor, and reduction in active interrogation activity.

Multi Sensor Data Fusion

On another level, data output (target reports) of various sensor systems is used within multi sensor tracking or data fusion algorithms to generate an optimized traffic situation picture combining the advantages of complementary sensors suppressing their respective disadvantages. Improved multi sensor tracking is another important element of surveillance that is addressed within this solution.

New non-cooperative surveillance system:

Several non-cooperative solutions could be proposed to respond to the evolution of the surveillance needs. During the SESAR 15.04.02 project, new releases of the operational requirements (SESAR 1 P15.04.02 D04) and of system requirements (SESAR 1 P15.04.02 D05) will be delivered. A first action will then to confront these requirements and the foreseen technologies.

Monostatic radar

Evolution of the technologies and new functionalities studied in other project could lead to emergence of new or improved monostatic radar.

The main topics related to this project are:

- Analysis and evaluation of the new monostatic radar technologies and/or functionalities
- Coordination with other project needs

Multistatic radar, e.g. MSPSR

As a distributed non-cooperative sensor system, Multi-Static Primary-Surveillance-Radar (MSPSR) is able to offer great potential, particularly when integrated with distributed cooperative sensor systems like WAM or ADS-B. Within the framework of the ongoing SESAR program, project 15.4.2, is working on the implementation and assessment of MSPSR, as well as the investigation of composite surveillance composed of ADS-B and WAM elements. Other topics related to this project are:

- Definition and application of the new ASTERIX standard for MSPSR transmissions,
- Evaluation of MSPSR on a comparative basis to WAM/ADS-B and to conventional ATC surveillance,
- Evaluation of composite surveillance with regard to common hardware usage, validation of ADS-B data as such and validation of ADS-B data with WAM (active and passive),
- Adaption and enhancement of multi-sensor data fusion (MSDF) tracker to evaluate the surveillance quality in comparison to traditional ATC surveillance.

Environment influence on non-cooperative surveillance

Whatever will be the non-cooperative solution selected for the future surveillance, these systems will have to take into account the evolution of the environment, (e.g. wind farm, new kind of target that will be for example studied during the PJ.13 project).

The main topics related to this project are:

- Analysis and evaluation of solution for mitigation of the adverse wind farm effects for non-cooperative surveillance
- Analysis and evaluation of solution for non-cooperative surveillance of RPAS (low RCS)

Secured Surveillance Systems

New surveillance systems are generally regionally distributed and operated using ground communication networks. While network security is addressed in a different project, the surveillance systems themselves are vulnerable to attacks and require means to increase their security. SESAR 1 WP15.4.5 and 15.4.6 addressed particular aspects of ADS-B security. This needs to be extended to other systems and then proven in an operational context.

Full Integration and exploitation of ADS-B in military platforms

SESAR 1 has investigated feasibility and possible advantages of incorporating ADS-B In/Out on-board military platforms (P9.24) and is demonstrating i4D and ASPA S&M functionalities in a mixed civil/military aircraft environment (P9.3). Results so far indicate that there is a great potential for civil and military community to benefit from military aircraft ADS-B In/Out capable. These include: traffic situation awareness for military platforms not having TCAS (e.g. fighters), full integration of military platforms in 4D Trajectory management, increased military effectiveness in management of airspace security incident management, …

Simulations will play a significant role in further demonstrating these benefits in more complex future environments with advanced functionalities. New emerging integrated military avionics with exploiting ADS-B technology could be used to demonstrate such functionalities with increased TRL with respect to SESAR 1 demonstrations.

Future ADS-B communication link

The purpose is to tackle the congestion of 1090MHz (Follow-up of current SESAR 9.22 project) to address the Future ADS-B communication link. It will encompass contribution to the definition of next ADS-B standard (RTCA DO-260C / EUROCAE ED102A+)

A link with PJ.11 (ACAS) will have to be considered, as well as with solutions dealing with new separation modes (in PJ.01, PJ.02, PJ.10).

Activities to be done

Based on the preparatory work and the results achieved within the ongoing SESAR program, the following topics should be carried forward:

- Composite surveillance to be extended in the test beds to incorporate also airport and ground providing seamless air-ground surveillance (including SMR, video plot extraction, induction loops, etc.).
- Surveillance Systems integration shall be addressed in greater detail - particularly with respect to composite systems (e.g. WAM and ADS-B or ADS-B and SSR)
- MSDF tracking systems to be extended to an integrated, seamless air-ground tracking and fusion capability to track and fuse these sensor data integrating airport surface, approach TMA and en route sensors (continental and oceanic tracking harmonization need to be addressed within the satellite based ADS-B solution).
- Real environment validation of the new ADS-B data link ED102A+
- “Study of the congestion of 1090MHz (Follow-up of current SESAR 9.22 project) to address the Future ADS-B communication link. E.N. this activity will be refined during the drafting of the DoW 0.9”
- Secured Surveillance Systems (mainly addressing ADS-B, WAM and MSPSR)
- Development of an automated test suite, where the vulnerability of ADS-B (“ADS-B threads”) can be assessed by standard procedures.
- Development/enhancement of monitoring tools.
- Enhancement or evolution of mono-static PSR thanks to new technologies according to new requirements defined in SESAR 1.
- Enhancement of MSPSR in its active component, plus the passive part to be extended to include not only illumination by DVBT and DAB, but also FM to achieve surveillance in higher altitudes,
- Investigation of alternative primary technology solutions to MSPSR,
- Enhancement of solutions for mitigation of the adverse wind farm effects for non-cooperative surveillance
- Enhancement of the non-cooperative surveillance performances against RPAS and all low RCS vehicle that could coexist in the supervised area.
- Cross-validation of ADS-B to be extended to validation with primary information from MSPSR and with the MSDF tracking as well,
- A full ASTERIX category 12 implementation along with an extension of service category 23 for MSPSR to be envisaged as a basis for the input data stream of the surveillance technologies into the MSDF trackers and evaluation tools of the parties,
- Security assessment of composite solutions.
- Analysis of impact of use secured ADS-B in safety nets, i.e. in case when ADS-B information is

used for hybrid TCAS/ACAS

- ADS-B in military platforms concept definitions, prototype development.
- ADS-B in military platforms verification and validation through simulation and/or flight trials.

Level of Maturity

TBW in high level which maturity level will have the artefacts of the solutions. In particular in case of prosecution from SESAR1 it is important to identify the SESAR1 achievements and the S2020 ambitions (I.e. SESAR 1 CNS solutions for which further work are required in SESAR 2020. Clear identification of what remains to be done.)

The following SESAR 1 solutions will be in evolution for SESAR 2020.

- Evolution of non-cooperative surveillance, e.g. but not limited to MSPSR
- Composite WAM-ADSB systems
- Video surveillance
- Surveillance Security
- ED102A+ Data link
- Integrated MSDF

Expected outcomes (and deliverables)

For this surveillance solution different deliverables are expected.

Concerning Composite surveillance, it is expected that prototypes will be produced to further produce analysis on seamless air-ground surveillance.

Tools will be defined and developed for Surveillance system performance monitoring and supervision, including ACAS and space-based ADS-B performance

Concerning the future new non-cooperative surveillance systems including systems to mitigate wind farm effect and for the surveillance of RPAS, it is expected that prototypes will be produced allowing further analysis on surveillance of conventional and low RCS vehicle.

Concerning to the secured surveillance system ED102+ ADS-B in/out prototype including validation - Continuation of the relevant SESAR 1 projects (9.22, 15.04.05a,b)

Major links and dependencies

Links to PJs implementing future concepts is provided in the dependency table.

PJ.14 activities have, in principle, dependencies with external standardization activities & organism, such as:

- FAA
- ICAO, for international standardisation
- EUROCAE WG51 SG4 developing new versions of ADSB-0106 and new version of GSURV-0113
- EUROCAE WG 41 developing updates of ASMGCS-0113, ASMGCS-0114
- EUROCAE WG 100 developing specifications for Remote & Virtual Tower.
- EU RULE NO. 1207/2011 - SURVEILLANCE PERFORMANCE AND INTEROPERABILITY IMPLEMENTING RULE (SPI IR)
- Coordination with Work Program of the ICAO Communications Panel (CP) and the Navigation Systems Panel (NSP)

- Coordination with standards activities performed within ICAO, RTCA, and EUROCAE

Validation of the Solution

This solution needs validation activities for the prototypes.

ENB table

PJ.14 shall ensure that appropriate results and prototypes are delivered in wave 1 maximizing the availability of ATM solutions in the first wave.

SESAR Solution PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance		MATURITY				
		SESAR 1	SESAR 2020			
		Maturity Level at the end of SESAR 1	Wave 1			Wave 2
			R6	R7	R8	
GSURV-0113	EUROCAE ED142 for 1090ES Wide Area Multilateration specifications	N/A				
ADSB- 0001	ED 126: Safety Performance and Interoperability Requirements for ADS-B in Non Radar Airspace (ADS-B NRA)	N/A				
ADSB-0002	ED-161: Safety Performance and Interoperability Requirements for ADS-B in Radar Airspace (ADS-B RAD)	N/A				
ER APP ATC 163	CWP & ground processing systems for ADS-B in Non-Radar Airspace (ADS-B NRA)	V3 (available, no R&D)				
CTE-S02c	Multi Static Primary Surveillance Radar	V2				
CTE-S03a	ADS-B station for NRA surveillance (ED-102)	V5 (available, no R&D)				

CTE-S03b	ADS-B station for RAD and APT surveillance (ED-102A)	V5 (available, no R&D)				
CTE-S03c	New ADS-B station for future ADS-B applications (ED-102A+)	V2				
CTE-S03d	Satellite based ADS-B technology	V2				
CTE-S04a	Wide Area Multilateration (WAM)	V5 (available, no R&D)				
CTE-S04b	Airport Multilateration (MLAT)	V5 (available, no R&D)				
CTE-S03f	New ADS-B receiver for vehicles	V5 (available, no R&D)				
A/C-48a	Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B	V5 (available, no R&D)				
ADSB-0003	ED-163: Safety Performance and Interoperability Requirements for ADS-B for Airport Surface Surveillance (ADS-B APT)	N/A				
CNS-0003-A	"Rationalisation of SUR systems/infrastructure for Step1"	V1-V2-V3 (available, no R&D)				
CNS-0003-B	"Rationalisation of SUR systems/infrastructure for Step2"	V1	V2	V3		
CNS-0003-C	"Rationalisation of SUR systems/infrastructure for Step3"		V1	V2	V3	
ADSB-0102a	ED102A ADS-B 1090 MHz Extended Squitter	V5 (available,				

		no R&D)				
ASMGCS-0115	Update of EUROCAE ED128 for A-SMGCS Guidelines for Surveillance Data Fusion	N/A				
CTE-S03e	ADS-B transmitter for vehicles	V5 (available, no R&D)				

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.14															
Source Project	Source Solution	PJ.14-01-01 CNS environment evolution	PJ.14-01-02 CNS Avionics integration	PJ.14-01-03 CNS Ground segment integration	PJ.14-02-01 FCI Terrestrial Data Link	PJ.14-02-02 Future Satellite Communications Means	PJ.14-02-03 Short Term FCI Data Link Technologies	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing	PJ.14-02-05 Development of new services similar to FIS-B to support ADS-B solutions for General Aviation	PJ.14-02-06 Completion of AeroMACS development	PJ.14-03-01 GBAS	PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS	PJ.14-03-03 Navigation system performance and requirements analysis	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	PJ.14-04-01 Surveillance Performance Monitoring	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	PJ.14-04-04 Satellite Based ADS-B
PJ.01 Enhanced arrivals and departures	PJ.01-03 Dynamic and Enhanced Routes and Airspace												▨	▨	▨	▨	
	PJ.01-05 ASAS Spacing with more complex geometry				▨										▨	▨	
	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA											▨	▨		▨	▨	
	PJ.01-07 Approach Improvement through Assisted Visual Separation														▨	▨	▨
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.				▨									▨	▨		
	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace														▨		
PJ.10 Separation Management En-Route and TMA	PJ.10-02A Improved Performance in the Provision of Separation				▨								▨	▨			
	PJ.10-02B Advanced Separation Management				▨								▨	▨			
	PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck				▨										▨	▨	
	PJ.10-01b Flight Centric ATC				▨												
PJ.14 CNS	PJ.14-01-01 CNS environment evolution		▨	▨	▨			▨									
	PJ.14-01-02 CNS Avionics integration	▨		▨													
	PJ.14-01-03 CNS Ground segment integration	▨	▨														
	PJ.14-02-01 FCI Terrestrial Data Link	▨				▨	▨	▨		▨				▨			
	PJ.14-02-02 Future Satellite Communications Means				▨		▨	▨		▨							▨
	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing	▨			▨	▨	▨			▨							
	PJ.14-02-06 Completion of AeroMACS development				▨	▨	▨	▨								▨	
	PJ.14-03-01 GBAS												▨				
	PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS												▨				
	PJ.14-03-03 Navigation system performance and requirements analysis										▨	▨		▨			
	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)				▨								▨				
	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance									▨							
SESAR1	#46 Initial SWIM								▨								

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.01	PJ.02			PJ.03a		PJ.03b		PJ.06		PJ.08		PJ.14											PJ.16	PJ.17		PJ.18	
Source Project	**Source Solution**	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB	PJ.02-02 Enhanced arrival procedures	PJ.02-05 Independent Rotorcraft IFR operations at the Airport	PJ.02-11 Enhanced Terminal Area for efficient curved operation	PJ.03a-03 Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface	PJ.03a-04 Enhanced Visual Operations	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.03b-03 Conformance monitoring safety net for Pilots	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	PJ.14-01-01 CNS environment evolution	PJ.14-01-02 CNS Avionics integration	PJ.14-01-03 CNS Ground segment integration	PJ.14-02-01 FCI Terrestrial Data Link	PJ.14-02-02 Future Satellite Communications Means	PJ.14-02-03 Short Term FCI Data Link Technologies	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing	PJ.14-02-06 Completion of AeroMACS development	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	PJ.14-04-04 Satellite Based ADS-B	PJ.16-03 Virtual Centre concept	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing	PJ.17-02 SWIM TI Federated Identity Management	PJ.18-01 Mission Trajectories	PJ.18-06 Performance Based Trajectory Prediction
PJ.14 CNS	PJ.14-01-01 CNS environment evolution														▨	▨	▨			▨									
	PJ.14-01-02 CNS Avionics integration													▨		▨													
	PJ.14-01-03 CNS Ground segment integration													▨	▨														
	PJ.14-02-01 FCI Terrestrial Data Link											▨	▨	▨				▨	▨	▨	▨	▨							
	PJ.14-02-02 Future Satellite Communications Means											▨					▨		▨	▨	▨			▨					
	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing													▨			▨	▨	▨		▨				▨	▨	▨		
	PJ.14-02-06 Completion of AeroMACS development																▨	▨	▨	▨			▨						
	PJ.14-03-01 GBAS		▨	▨	▨	▨								▨															
	PJ.14-03-02 Multi Constellation / Multi Frequency (MC/MF) GNSS									▨				▨															
	PJ.14-03-04 Alternative Position, Navigation and Timing (A-PNT)	▨				▨								▨			▨												
	PJ.14-04-01 Surveillance Performance Monitoring					▨	▨	▨	▨	▨	▨																		
	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance						▨	▨													▨							▨	▨

Regarding PJ15 Common Services, Project B04.05 Options for High Level Architecture, will examine the introduction of Common Services in SESAR. A Common Service is “a service providing a capability in the same form to consumers that might otherwise have been undertaken by them.” The rationale for using them is to reduce the number of times a given service is developed and deployed and increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and may need to support the verification of common services defined in SESAR 1.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management, runway environment…),
    - ATM Operational Experience (En Route, TMA, Network management, runway environment…),
    - ATC users requirements (ground & air),
    - Airspace users, airport operators and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (Airport systems, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
    - Performance and Transversal Areas Assessments
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

In addition to the specific deliverables mentioned under each of the solutions, the following final deliverables should be considered:

- Feasibility report
- Technical specification
- Cost benefit analysis

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.15 Enabling Aviation Infrastructure – Common Services (PJ15)

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. The advent of service orientation and the use of open standards create opportunities for identifying such common capabilities amongst certain stakeholder groups and encourage their use in the de-fragmentation of ATM. Applicable to any capability supporting Air Navigation Services or their related functions, they can be provided at European, network, FAB, local or other level.

While the primary benefit of a Common Service is to improve the overall cost effectiveness of a capability. Common Services can also benefit one or more performance areas such as safety, capacity, environment and predictability. However, as the expected contribution of the SESAR concepts to meeting the SES Goal for cost-effectiveness is small (12.5% for Steps 1 & 2; B04.01 Performance Framework D41, Step 1 Target 5%, Step 2 Target 7.5%). The European ATM Master Plan and SESAR 2020 need to show in the definition of the future high level architecture the different options for the de-fragmentation of the ATM system through the provision of harmonised or Common Services.

The conditions for establishing a Common Service needs to be analysed in the context of the solutions being supported. Introducing a Common Service will change how a solution is delivered and this is likely to change organisational relationships between the stakeholders due to the provision and consumption of the new service. As a consequence, this is also likely to result in a change to the enablers specified as the requirements on their relative assets are modified. Looking at such changes in organisation is not a primary task for the Industrial research projects as they will be focussed on defining and validating operational solutions. The role of this project, building on the results from SESAR 1, will be to work with them to develop and validate the underlying principles of Common Services by identifying opportunities to achieve the above-mentioned benefits.

SESAR 1 undertook a study to examine changes to the high level architecture and 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 services’ 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 services’ 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 work carried out in SESAR 1 was a study that looked at a limited number of candidate services and developed a primarily logical view of the changed architecture. The intent being to develop and refine a method for discovering and defining common services for wider application. SESAR 2020 moves from the study phase to the examination of the business and physical impact of providing specific capabilities needed to support a Solution through the provision of a Common Service.

The solution projects in SESAR 2020 will be primarily focussed on the development and validation of new concepts of operation and their supporting technologies; the Enabling Infrastructure Projects on verifying the capability of supporting infrastructure and the rationalisation of it use. As a consequence, neither type of project are likely to focus on enhancing the benefits of a specific solution by examining alternative organisational arrangements for providing one or more of the required capabilities needed for a solution, nor the impact that such arrangements would have on the architecture.

Project 19, ATM Design, focusses on the overall architecture design and the consistent and coherent integration of content from the programme.

The added value of this project is to enhance the benefit of operational solutions, especially their cost effectiveness, by identifying opportunities to provide them through alternative organisational arrangements. This is achieved through the discovery, definition and validation of common services and their enabling elements in the operational solutions.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

SESAR 2020 will focus both on the further definition and validation of the Common Services examined in SESAR 1 and the identification and definition of additional services through the discovery of opportunities in the solution projects. The latter may include services identified in SESAR 1 but not pre-selected for further definition.

The aim for each service considered, will be to reach a mature enough level of definition to proceed to the industrialisation phase and to start any rulemaking or standardisation necessary to support 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.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

During Wave One, the project will follow the processes and methods defined by Project 19, ATM

Design & Integration, and work with the other solution and enabling projects to:

- Define and validate the Common Services initially defined by Project B04.05 in SESAR 1 by:
  - Developing and defining during the early part of the V2 development phase the business model for the provision and consumption of the Common Service, including the definition of the relative capabilities of each party and the Service Level agreement ,
    - During this activity it will be necessary to consult with appropriate stakeholders to ensure that the wider aspects of the proposed business model are understood and accepted by the community. As a result, the proposed business model may need to be changed,
    - In some cases the Common Service will be applicable to a number of solutions in the programme, if this is so, the business model and definition of the relative capabilities will be adjusted accordingly.
  - Describing the operational model of any business processes necessary to support the relationship between the service provider and consumers,
  - Defining the changes to the architecture supporting the original solution in order to support a Common Service,
    - This will include the further evolution of the European ATM Service Portfolio,
  - Developing the necessary mock-ups and/or prototypes and integrating these, where necessary, into the validation platforms for the solution concerned,
  - Verifying the changes to the architecture and requirements, and
  - Validating at V3 maturity level the original solution in co-ordination with the project concerned using the common service to identify the benefits obtainable.
    - In some cases the validation of the original solution using a common service may not be necessary as the capability provided may exhibit sufficient separation to be considered alone. For example the Virtual Centre
  - The outcome of this activity may be used to update the SPRs/INTEROP of the relevant ATM solution projects.
- Discover further candidate Common Services made possible by the solution development work in the rest of the programme. This work will inform the programme via the yearly content integration process of any opportunity to further define and validate common services during the remaining period of Wave 1 and in Wave 2. This work will make use of:
  - SESAR Service Portfolio; SESAR 1 may be describing candidate common services that the B04.05 may not be aware of,
  - Discovery of candidate Common Services from the analysis of the architecture developed in PJ19. Capabilities are likely to be developed that are common to more than one solution and thus their provision as a Common Services may impact more than on solution project.
- Integrate the operational, service and technical architecture content that was developed in the two activities above that describes the Common Services into EATMA.

Interaction and Dependency

The level of interaction and therefore mutual dependency between this project and the solution and enabling projects will depend upon the solution being supported by the Common Services and the extent to which the capability can be separated. The following three levels of interaction are considered in order to address the likely impact of the solution and enabling projects.

Low: A low level of interaction would be where the capability being supported by the Common Services can be seen to be loosely coupled in the overall solution. There would therefore be minimal impact upon the validation infrastructure of the original solution. The additional work would be to assess the business processes supporting the customer provider relationship and the service interactions supporting this activity. An example being the provision of airspace data from a common source rather than a highly fragmented one using the same service interface. No additional validation necessary of the concept.

Medium: A medium level of interaction would be where the capability provided by the common service affects the original concept by changing the nature of the information provided resulting in the need to revalidate the concept. An example would be the use of the Global surveillance capability.

High: A high level of interaction would be where the use of the common service affects the way that the original concept is supported. The separation of the capability would result in a change to the underlying validation infrastructure and new prototypes would need to be developed and integrated with original IBPs. The concept would thus need to be revalidated using the Common Service.

From a complementary perspective, it is expected that during Wave 1 the development of Common Services mainly relates to solutions that are or will be mature at the latest in Release 7 and will target their application in VLDs, whereas for several SESAR solutions that are foreseen to reach V3 maturity only in Wave 2 the identification and development of common services will be an integral part of the solution development.

This project will, during Wave 1, focus on the validation of the following Common Services:

PJ15 – 01: Sub-regional Demand Capacity Balancing Service

The purpose of the Sub-regional Demand Capacity Balancing (DCB) Service is to facilitate an improved usage of the airspace at sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed.

The scope also includes an AOP Common Service to facilitate the integration of AOP information into the NOP.

Different input information from different ATM stakeholders are collected, as long-term demand information from regional DCB, capacity information from ANSPs and Airports, demand information from AUs and Military or weather forecasts from MET info providers. As output, the Service produces optimal capacity balancing for sub-regional airspace, encompassing the time window from the pre-tactical phase until the moment prior to the real-time operation phase.

Working in the context of a collaborative network, especially with the network management function and the local DCB capabilities at the units, this Common Service is intended to offer a DCB capability in an open and standard manner to a number of ANPS and airports. The DCB service would thus work to optimise the operation of a highly integrated part of the network by working closely with the units to balance demand against the available capacity of the different stakeholders.

Several potential benefits could be highlighted, as cost reductions by optimizing the operational use of local ATSUs, increased capacity and reduced flight delays due to more accurate planning, which also leads to less fuel consumption.

Assumption: **Low** level of interaction as Sub regional DCB will be developed in PJ09

PJ 15 – 02: Delay Sharing Service

The Delay Sharing Service operates the AMAN functionalities within an extended horizon to provide local and overall arrival sequences for planning and tactical operational purposes in a cross border environment.

Input information required by the Service is flight trajectories, surveillance tracks and CDM data. When analysing and processing data, different planning priorities or strategies could be applied, resulting in different delay apportionments to those initially proposed in order to balance workload for the centres affected, and hence arrival sequences. These sequences, along with the planning times and all actors' XMAN status are distributed as output data to the consumers.

Working closely with PJ01 and VLD 1-4, the Project will validate a cost effective delay sharing capability provided as an independent Common Service in an open and standard manner to a number of area control centres covering the requirements for a group of airports operating in complex and integrated airspace. The implementation of this Service should bring many and diverse benefits, as enhanced airspace capacity and runway throughput, optimized flight trajectories, reduced delays at network level, less holding time and less fuel consumption.

To provide this Service, a certification is mandatory to ensure full compliance with the Interoperability regulations.

Assumption: **Low** level of interaction as delay sharing concept will be developed in PJ01.

PJ15 – 08: Trajectory Prediction Service

The function of the Trajectory Prediction (TP) Service is to compute and distribute an accurate and consistent 4D trajectory and update it as the flight progresses. The output could be used during different flight phases: to propose an initial reference trajectory in the planning phase, as input for DCM during the tactical phase or facilitate transfers during the operations phase.

The Service needs to receive airspace data (including TMA and runways configuration), ATC restrictions, requests from ATSUs, MET and surveillance data and airborne performance information. State of the art software algorithms will compute and generate dynamically updated trajectories, including list of crossed airspace sectors. A solid communications infrastructure is required to support all information exchanges.

TP Service is aimed to cover the pan-European area or at FAB level and should ensure high degree quality level in terms of service availability, response time and data accuracy. As this Service is safety critical, measurements should be taken to protect the data security and the service provider needs to be certified.

A consistent flight trajectory provides a common picture for all stakeholders, delivering improvements within different performance aspects as safety, capacity, predictability and environmental impact. A common implementation of the service should bring cost reductions as well.

The exact description of this service and its relationship with IOP and the RBT will be defined with PJ18 during the V2 maturity phase.

Assumption: **Medium** level of interaction as TP concept will need to be developed in conjunction with PJ18.

PJ15 – 09: Virtual Centre Service

The Virtual Centre Service aims to provide ATS (mainly ER/APP) within the union of airspace areas controlled by distinct ATSUs. By using standardised operating methods, procedures and technical equipment, the Service would be perceived as a unique system from the consumer's perspective, rather than the current fragmented situation. The range and QoS of the ATS provided shall be the same as now, or even enhanced.

It is important to state that no physical consolidation of ATSU facilities is foreseen, since the target is to achieve a virtual defragmentation, ensuring complete operational and technical interoperability between all stakeholders. It means that only operational information and data are shared, and the Virtual Centre will use them to monitor and dynamically balance the workload between the different workstations.

Three elements are essential to make the Service feasible: standardised workstations which use open systems and certified applications, data and information service providers who offered secured contents and in last place common standardised interfaces to enable interoperability between systems.

Regarding the regulatory aspect, changes within the existing regulation are expected to explicitly standardise the new operational procedures and technical equipment. The service provider needs (European, National and/or local) certifications while the controllers should receive new training to provide cross border services.

Improved cost effectiveness is expected from a more efficient use of facilities and resources and economies of scale. The new concept also supports the development of FABs by providing cross border services and brings more flexibility when assigning airspace sectors.

Assumption: **Low** level of interaction as Virtual Centre concept will be developed in PJ16

PJ15 – 10: Static Aeronautical Data Service

The function of the Static Aeronautical Data Service is to provide static aeronautical data in digital form to be used by different ATM systems (e.g. Safety Nets). The output is an AIXM-compliant dataset whose subsets can be retrieved by individual requests demanding specific geographical areas, attributes or functional features.

Input aeronautical data are collected from internal and external sources, conveniently validated, processed according to the regulatory requirements to ensure quality and integrity level and finally generated as dataset. Configuration management tools should be implemented to better satisfy the consumers requirements.

The accuracy and consistency of the data provided should be predictably enhanced, leading in turn to safety improvements, while the use of high-efficiency automated processes would allow cost reductions by a high margin.

Assumption: **Medium** level of interaction as data will need to be developed with solution projects.

PJ15 – 11: Aeronautical Digital Map Service

The Aeronautical Digital Map Service provides digital maps ready to be used by different ATM systems (e.g. Safety Nets) when performing separation functions. The output is highly customizable in order to meet the different requirements from the consumers and easily convertible among different digital formats, as AIXM, GML, XML, etc.

The accuracy and consistency of the data provided should be predictably enhanced, leading in turn to safety improvements, while the use of high-efficiency automated processes would allow cost reductions by a high margin.

The Service collects aeronautical data from authorised sources, filters them and produces individual map graphics depending on the specific usages as geographical area or system functionality. In this sense, configuration management tools should be implemented to better satisfy the consumers requirements.

Given it is an offline service, no resilience measures have to be considered, but the output data should achieve high degree of quality, integrity and authenticity for safety reasons. Assumption: medium level of interaction as data will need to be developed with solution projects

Assumption: **Medium** level of interaction as data will need to be developed with solution projects

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.15-01: Sub-Regional Demand Capacity Balancing

Solution Description

Description	**Function of the service**: Plans the optimal use of operational ACC resources and demand management measures to facilitate AU (civil and military) desires, based on the regional plan and within the prevailing business performance framework, for the rolling day of operation. The plan also includes measures for managing uncertainty (including weather) and cross border requirements such as XMAN. The scope also includes an AOP Common Service to facilitate the integration of AOP information into the NOP. The service supports the Local Traffic Manager in the tactical operation in managing unforeseen events by: - tactically adapting plans and developing further options as uncertainties develop - tactically interacting with peers, AUs and the regional NMF service to develop / implement tactical interventions The service is active from year before the time of operation to just before the time of active operation within the sub-regional airspace (generally 2 hours before the time of active operation). The primary focus is the window encompassing pre-tactical to just prior to activation. Assumptions: - Availability of live European Network Management, FDP, Surveillance, Capacity, Operational Status (ACC and local Airports), Predictive Demand information

	Output/result of the service: Improved Sub-regional plans, reducing the need for unplanned change on the day of operation. Support to tactical operation, at the time of operation, ensuring that any disruption is managed within the tolerances of the European network. **Flight phase**: planning, tactical and post operational. **Safety:** Elements of the tactical interaction have a safety dimension due to the relationship with controller workload. **Security considerations**: The actors relating to the service are widely distributed across Europe (some elements throughout the world). Elements of the information may be provided via the Internet. Assurance is required that the information is provided only to the correct consumer / server. However, the security requirements are not as stringent as for the ATC. **Regulatory impact**: European regulatory change may be required in order to FULLY deploy this service. Candidate area for impact are: 691/210 (Network Management Performance)
Area of Coverage	The service relates to the area covered by a collection (at least 2) of ACCs. CDM activity relating to the service occurs across Europe. Information relating to the service is required to be available world-wide.
Quality of Service	Service Availability - Major loss of service to customers shall not occur more than once in 5 years and shall not last more than an hour (information integrity maintained) - A minimal sub-regional service shall be maintained at all times (the service may be provided using supervisory operational staff if necessary). - Information provided by the sub-regional function shall be validated as being sufficiently accurate for its intended purpose. Priority is given to the most tactical information which would cause the greatest short-term impact. In particular, sort term measures impacting controller workload may be safety related depending on prevailing operational conditions. Accuracy, timeliness and assurance of information improve as appropriate as the time of operation approaches.
Service patterns	Outsourcing
Timeframe of opportunity	From now and for 30 years.
Expected Benefits	Enhanced predictability of the Sub-regional operation will lead to

	reduced: -Cost Effectiveness - Delay (in all flight phases), - CO2 emission, - AU operating cost, - ANSP operating cost. The service provides the ability to optimise sub-regional operations over time, in order to manage compliance with multi-dimensional business targets.
Consumer / Customer Segments	Local Traffic Manager Airlines Airports ANSPs (ACC and TWR) Military NMD Other Sub-Regions End Customer (travelling public)
Key Activities	Provision of long term demand information from the Regional service (Collation of information from AU, Airports, Military, Met, ANSP). CDM processes relating to planning for the day of operation, with a continuously improving level of planning information accuracy over time (years to day of operation). Key milestone are the finalisation of operations room staffing / configuration (1.5 to 3 month before day of operation) and the day before operation when the daily plans are finalised with accurate met information. Tactical CDM on the day of operation in relation to Local issues Post operation: performance reporting, operations analysis and improvement.
Key Resources	Regional and Sub-regional and local Network Management information infrastructure, Regional / Sub-regional / Local applications, User (Civil and Military) provision of demand planning information ANSP / Airport provision capacity planning information. Met forecasts Appropriate AU and NMF related users for CDM purposes.

Key Information Flows	Long term demand (civil and mil where possible) information from Regional to Sub-regional Network Management Function (NMF) Local ACC capacity information to Sub-Regional NMF Peer to peer Sub-regional information and CDM processes Mil information updates to NMF (Sub-regional) Airport information to NMF Sub-regional Operational status information to AU and Regional NMF High resolution Met information to NMF (sub-regional) Network Management initiatives to AUs, Regional NM and Airports Provision of pre-tactical demand information to NMF (Sub-Regional) from NMF (Regional) Real-time update of inbound externally active aircraft. Accurate sub-regional airport departure information (scope includes adjacent Sub-regions) Local operational issues (e.g. staffing, major system failures) to Sub-Regional NMF It should be noted that, generally, information used during the tactical phase is required to be more accurate, timely and assured than the Regional need due to its direct impact on the operation / safety functions.
Source / Reference	OFA05.03.07 Network Operations Planning, which supports the following OFAs: OFA05.03.04 Enhanced ATFM processes OFA03.01.03 Free Routing, OFA03.01.04 Business and Mission Trajectory, OFA04.01.02 Enhanced Arrival and Departure Management, OFA05.01.01 Airport Operations Management, OFA05.03.01 Airspace Management and FUA, OFA05.03.01 Airspace Management and FUA, OFA05.03.03 Dynamic Airspace Configuration, SESAR 20202 Project 09 Solutions 01, 03

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		SESAR 2020	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

SESAR Solution PJ.15-02: Delay Sharing Service

Description	**Function of the service:** The Delay Sharing Service provides functions necessary to operate Arrival Management with an extended horizon (XMAN) in an environment where multiple actors are involved e.g. multiple Airports, AMANs, ACCs, UACs and NM (e.g. Cross Boarder Arrival Management). These functions are: - XMAN Sequencing / Planning - Management of Delay Sharing Strategies, MOPs - Delay Sharing / Apportionment - Arrival Management Information Distribution to all involved actors - Provision of XMAN Status of all involved actors - Provision of Overview of XMAN Planning for Situational Awareness purposes as well as local and network impact assessment This Service will have to implement several interfaces for different consumers and purposes. **Output/result of the service:** Local (e.g. total delay) and overall (e.g. apportioned delay) XMAN Planning results aggregated to serve different purposes of the involved actors (queue management, network and local impact assessment, local ATFCM process, workload planning) **Flight phase:** planning/tactical (e.g. departure delay, local ATFCM measures), real-time/operations (e.g. speed advisories) **Safety considerations:** Fall-back scenario is operating without XMAN, failure consequences are: reduced capacity & performance, increased fuel burn & environmental impact. It cannot be excluded that wrong sequencing decisions can be made based on wrong XMAN Planning data provided.

	Security considerations: See safety considerations. Necessary security features could be considered as on a "medium" level. **Regulatory impact:** Arrival Management falls under Interoperability IR 552/2004, therefore certification of the service provider will be necessary (to be confirmed), XMAN is compliant with regulation IR 716/2014 (PCP)
Area of Coverage	Sub-regional (FAB or groups of states), local
Quality of Service	Availability: As not safety critical no 100% availability is required. The following numbers are only given to illustrate this: A service uptime of 99,73% is required with a maximum system downtime of 24h per year (including failure & scheduled maintenance) and a mean time between failures (MTBF) of 2000h is required. Maintenance disruptions of the service are expected to take place scheduled and pre-notified during the night hours (0am to 4am local time). Data Quality: To be able to use the data in Cross Border Arrival Management a trajectory accuracy of +/- 2 minutes 90 minutes out shall be achieved (within 2 Sigma) for airborne flights supposing increasing accuracy nearer to the destination airport. Transmission Frequency: Ad-Hoc (if significant impact on the process, dependent on interface/consumer) Max Time of Delivery: < 1 s for approach centre, airport; < 10 s for en-route centre (examples, dependent on interface/consumer)
Service patterns	Several capabilities provided by the service can be considered as new capabilities (e.g. Delay Apportionment) others (e.g. XMAN Sequencing / Planning) can be considered to be provided through outsourcing, consolidation and partnerships
Timeframe of opportunity	Step 1 operations. The service can be provided for an unlimited period of time from the time of deployment. When full IOP capabilities are rolled out a transition of the service towards IOP communication will have to be performed.
Expected Benefits	**Environmental:** As fewer holds/heading and less holding time are expected, fuel consumption and noise will be reduced. **Flight Efficiency:** Optimized flight profiles. The flight efficiency for flights going into high capacity airports will be higher than standalone AMAN **Cost:** Consolidation of System development, provision and maintenance. The implementation of a Common Service of this kind can lead to the cost efficient fulfilment of part of IR 716/2014 (PCP). **Capacity:** Optimization of RWY throughput **Delay:** reduced delays at ATM network level **Safety:** Less Holding leads to improved safety

Consumer / Customer Segments	**Primary:** ANSPs, NM, airports **Secondary:** airspace users, AOCs, FOCs
Key Activities	- XMAN Sequencing / Planning - Management of Delay Sharing Strategies, MOPs - Delay Sharing / Apportionment - Arrival Management Information Distribution to all involved actors - Provision of XMAN Status of all involved actors - Provision of Overview of XMAN Planning
Key Resources	System infrastructure, general software capabilities (e.g. supervision, logging, data recording), specific software algorithm, communication infrastructure, data for establishing the XMAN Horizon (Flight plan data & Surveillance data), Trajectory Prediction capabilities, personnel for system maintenance.
Key Information Flows	**Input:** Tracks, Shared trajectories (e.g. EFD data), A-CDM data, Configuration data (static & dynamic) **Output:** Arrival Sequences, XMAN planning times and advisories, XMAN Status of involved actors (e.g. delay situation at airports, delay absorption capabilities of upstream centres)
Source / Reference	OFA04.01.02 Enhanced Arrival and Departure Management SESAR P5.6.7 material FABEC XMAN project material SESAR 2020 Project 01 Solution 01

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		SESAR 2020	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

SESAR Solution PJ.15-08: Trajectory Prediction	
Version Number	00.01.02
Description	**Function of the service:** -Manage * the flight intents * the environment data (SID-STAR, runways, MTO…) * the constraints (ATC, NM, …) -Compute and maintain an updated trajectory according to the flight progress **Output/result of the service**: updated and accurate 4D trajectory **Flight phase:** The TP is used from the planning phase to post analysis. The TP is used during the planning phase in order, for its consumers, to propose an initial shared or reference trajectory and participate in the collaborative decision. The TP is used during the tactical phase. It helps for distribution and responsibility transfer real-time/operations, **Safety considerations:** Since this service will be used for ATSUs identification and ATC operations, its availability and performance are safety related. The TP enables MTCD, AMAN, LTCM… and possibly other tools contributing to improve safety **Security considerations:** As for SAFETY the TP must provide the service in a secure manner, and be protected against a deny of service **Regulatory impact:** -Interop IR 552/2004, -Since this service is crucial, the service provider will have to be certified
Area of Coverage	Regional : --> European level : one service provider for all Europe (Centralised) Sub regional : --> One service provider per FAB level or group of states
Quality of Service	-**Availability** : High (>99,9%) by use of redundancy **-Response time :** consistent with supported services needs and distribution service capacity (ATSUS requests) -**Accuracy of data**: High , consistent with supported services needs

Service patterns	Outsourcing and or Consolidation
Timeframe of opportunity	Could be applicable by the end of PCP period and basis for next CP.
Expected Benefits	Same trajectory ensured for all relevant ATSUS (according to the area of coverage) Support for new common services based on TP enabling the delivery of benefits concerning Safety, Capacity, Environment, Flight efficiency Cost efficiency as this could be a common service implementation
Consumer / Customer Segments	ANSPs, airlines, airports, Network manager, Military
Key Activities	Route management according to airspace data Flight script management taking into account LOAs, ATC constraints and ATSUS inputs Trajectory management taking into account met data, surveillance data & aircraft performances Crossed volume management Data logging for performances and post analysis
Key Resources	System infrastructure, communication infrastructure, data accuracy
Key Information Flows	**Input:** Airspace data (including TMA and runways configuration), LOAs, ATC restrictions & ATSUS requests Meteo data, Surveillance data, Aircraft data **Output:** Dynamically updated trajectory (including list of crossed volumes)
Source / Reference	B4.5 workshop + CS2 (partly)

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		**SESAR 2020**	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

SESAR Solution PJ.15-09: Data Centre Service for Virtual Centres

Service Name	Data centre Service for Virtual Centres
Version Number	00.01.00
Description	**Function of the service:** The Virtual Centre Service provides Air Traffic Services (mainly ER and APP) within a volume of airspace which is the sum of the airspace areas previously covered by distinct Air Traffic Service Units (ATSUs). While in the past ATS was provided in a fragmented way in each airspace area, the new Service would be perceived as a unique system from the consumer's perspective, by using fully standardised methods of operation, information, procedures and technical equipment. With this Service, the service providers (possibly ANSPs) do not need to consolidate their physical facilities, which would help to avoid some potentially critical obstacles from social, political and regulatory sides. Instead, the participating providers would achieve a virtual defragmentation which enables them to jointly and effectively manage the airspace controlled by the newly created centre. Arrangements between providers shall support a complete operational and technical interoperability. ATSUs are therefore responsible for the collection and sharing of any data/information related to the provision of ATS (e.g. airspace situation, flight plan, surveillance data...) with the Virtual Centre. Taking into account these data inputs and the availability of resources, the Virtual Centre will balance the actual workload and assign dynamically the different airspace sectors among its workstations, always looking for the best performance possible. The Virtual Centre Service will require the following key concepts to make it feasible:

	- Standardised workstations for controllers, which are located at the Virtual Centre, by using open systems and certified and "pluggable" applications. It includes the architecture, its functionalities and the related procedures in order to permit common working processes across the whole European industry. Due to the existing regional and local specificities in the ATM operating environments, it is necessary to have a portfolio of certified "plug-in" applications able to function in all workstations but performing particular functions. - Data and information service providers offering security protected contents, in order to prevent their corruption and/or loss and guarantee the data sovereignty for the involving states. Multiple providers could deliver such data services, so the Virtual Centre and ANSPs are free to purchase what they consider as the best option from external commercial data suppliers or even other ANSPs. - Common standardised interfaces between the workstation and the systems providing data inputs. It will not be necessary for the Virtual Centre to acquire the same technical equipment from the same manufacturer, as long as these systems are interoperable and act as open platforms.
	Output/result of the service: Provision of (En-Route & Approach) Air Traffic Services in a large airspace block (e.g. FAB)
	Flight phase: real-time/operations
	Safety considerations: - Causes: communications failure; workstations malfunction; physical facilities malfunction, lack of data / information provided by external suppliers - Consequences: 1) In case of ATSU malfunction, it is necessary to use data/information provided by other ATSUs or external providers 2) In case or multiple units or communications failure, it would result in no or partial provision of ATS, requiring units outside the area covered by the Virtual Centre Service to provide ATS, if it is possible - Measures: a backup Virtual Centre as contingency solution
	Security considerations: - Necessary to protect all information received from corruption and loss due to their operational importance, especially those sovereignty-related data which could imply safety issues. - Measures: use of encryption for critical data / information
Area of Coverage	Regional Sub-Regional (FAB or group of States)
Quality of Service	The range and QoS of the Air Traffic Services provided shall be the same, or even enhanced, in comparison with the current situation

Service patterns	Partnership
Timeframe of opportunity	Fully operational after an estimated transition period of 15-20 years, allowing a step-by-step synchronization
Expected Benefits	Cost efficiency: - Economies of scale - More efficient use of facilities, by adapting the number of them to the workload - More efficient use of human resources (ATCOs), by facilitating their mobility among different facilities - Possibility of purchasing individual services from competitive suppliers, instead of acquiring complete systems
	Performance: - Support the development of FABs and the overall FAB network, by introducing effective load sharing processes and providing cross-border services - More flexibility to assign airspace sectors, depending on the resources available - Less complex systems and processes resulting in enhanced robustness and safety - Business continuity (almost 100%)
	Capacity: increase (10% estimated) due to more efficient assignment of airspace sectors
Consumer / Customer Segments	Airspace Users Network Manager
Key Activities	Collection and processing of radar / surveillance / MET / airborne data Trajectory prediction and comparison Airspace monitoring Air Traffic Flow and Capacity Management Provision of Air Traffic Services (ER & APP) Workload balancing Dynamic assignment of airspace sectors
Key Resources	Data communications infrastructure Voice communications infrastructure Standardised workstations for controllers Open systems, standardised interfaces and certified "plug-in" applications Data and information service suppliers
Key Information Flows	Virtual Centre Service --> Airspace User: operational procedures, CTA, departure clearance...
	Airspace User --> Virtual Centre Service: acknowledges,

	requests...
	ATSU --> Virtual Centre Service: Data/Information (airspace situation, surveillance data…)
	Virtual Centre Service --> Data/Information Service Provider: service request
	Data/Information Service Provider --> Virtual Centre Service: required Data/Information
Source / Reference	Virtual Centre Model, proposed by Skyguide SESAR B4.4 Project

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		**SESAR 2020**	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

SESAR Solution PJ.15-10: Static Aeronautical Data Service

Version Number	00.01.01
Description	**Function of the service:** The service provides digital static aeronautical data as scoped by AIXM for the usage in ATM System components like SDD and Safety Nets, as well for simulation systems and other systems using digital aeronautical data. The data can be requested in terms of geographical coverage and specific features and can be tailored in terms of display attributes and individual structures of layers. **Output/result of the service:** Digital Aeronautical Data as an AIXM data set. Specific subsets of the data provided can be retrieved by individual requests. **Flight phase:** offline

	Safety considerations: The aeronautical data may be used in safety critical Systems. But no resilience measures and failure consequences for the providing systems have to be considered as the service operates offline. **Security considerations:** As the aeronautical data is safety critical, data quality, integrity and authenticity, for the entire data chain has to be ensured. **Regulatory impact:** ADQ 1 applies for the entire data chain. European service providers have to comply with EU IR 73/2010.
Area of Coverage	Regional (Europe), sub-regional (FAB or groups of states), local or logical (e.g. ECAC area)
Quality of Service	No strict availability requirements for service provision. Data Quality has to comply with EU IR 73/2010.
Service patterns	New capability / joint coordinated activity
Timeframe of opportunity	The service could be available within 3-5 years and could be operated unlimited.
Expected Benefits	**Safety:** High safety benefits can be achieved by improving the consistency of data in the area of coverage and media breach free provision from authorized sources. **Cost Efficiency:** Through automated processes high efficiency of digital data provision is achieved. By this costs can be saved by a high margin.
Consumer / Customer Segments	ANSPs, military, data publisher (e.g. Jeppesen / LIDO), FMS System Provider (e.g. Honeywell), Airspace User, SAR Provider …
Key Activities	Collection, generation and processing of aeronautical data according to EU IR 73/2010 by organisational, procedural and systemic measures to fulfil the regulatory requirements in order to achieve a high level of quality, integrity and reliability of the aeronautical data set.
Key Resources	Communication infrastructure, System infrastructure, Software (CAD, GIS, database, ...), validated aeronautical data from authorised sources, staff
Key Information Flows	**Inputs:** validated aeronautical data from authorised external and internal sources **Output:** Digital Aeronautical Data as an AIXM data set

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		**SESAR 2020**	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

SESAR Solution PJ.15–11: Aeronautical Digital Map Service

Version Number	00.01.01
Description	**Function of the service:** The service provides digital maps for usage in Tower and Centre ATS System components like SDD, Safety Nets, as well for simulation systems and other systems using digital geographical maps. The maps can be tailored in terms of geographical coverage, contained features, display attributes, individual structures of layers and digital format (e.g. GML). **Output/result of the service:** Digital maps tailored for specific application **Flight phase:** offline **Safety considerations:** The digital maps are safety critical as separation is performed based on map information. But no resilience measures and failure consequences have to be considered as service operates offline. **Security considerations:** As the maps are safety critical data quality, integrity and authenticity of data, from the raw data up to the resulting map product has to be ensured. **Regulatory impact:** ADQ 1 applies for raw data upstream for production of digital maps. No Certification issues besides QM
Area of Coverage	Regional (Europe), sub-regional (FAB or groups of states), local or logical (e.g. ECAC area)

Quality of Service	Offline data service, no strict availability requirements. Accuracy and quality of data has to be ensured by validated data sources. Correct geodesic processing of raw data has to be ensured. Data accuracy has to meet the requirements of the consuming systems.
Service patterns	outsourcing, consolidation
Timeframe of opportunity	The service could be available within 3-5 years and could be operated unlimited
Expected Benefits	**Safety:** High safety benefits can be achieved by the consistency of data in the area of coverage and a common high data quality standard. **Cost Efficiency:** Through automated processes high efficiency of digital map production is achieved. By this costs can be saved by a high margin.
Consumer / Customer Segments	ANSPs Military
Key Activities	- Consuming of validated aeronautical data from authorised sources. - Comprehensive configuration management of consumer requirements for digital maps - Identification, filtering of relevant data for several specific usages - Preparation of individual map graphics for several specific usages - Transformation in consumer specific formats, e.g. AIXM, GML and other XML based formats - Automated, traceable, safe, distribution of digital map products
Key Resources	Communication infrastructure, System infrastructure, Software (CAD, GIS, database, ...), validated aeronautical data from authorised sources, staff
Key Information Flows	**Inputs:** validated aeronautical data from authorised sources, individual requirements of consumers and target systems **Output:** Local and system specific digital map sets
Source / Reference	Identified during DFS internal B4.5 brainstorming

List of Business Improvements:

Business improvement Steps (BIs) related to cost-effectiveness improvement are to be created during SESAR 1 and SESAR 2020 to define opportunities for performance improvement through the deployment of Common Services. The improvement step for this service will be identified in SESAR 1.

Maturity			
SESAR 1		**SESAR 2020**	
June 2014	December 2016	2015-2018	2018-2020
-	V1/V2 (initial services from B.4.5)	V3 (initial services from B.4.5) V2 (more services)	V3 (more services)

Performance Goals

The main performance goal is cost-effectiveness achieved through economies of scale in in the provision of commonly required capabilities enabled by standard interfaces to the services that make them available to consumers. This will support lower overall lifecycle costs, including maintenance and training and encourage the introduction of more open markets and competition.

Indirectly, the solutions developed within this project will contribute to achieve performance goals in ATM Solution projects related to:

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

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
All PJ.15 SOLUTIONS **Generic Solution to a Common Service**	**N**	Common Services require synchronization of different organizational entities at and above national level and thus require a Network approach for their deployment. Network-wide synchronization of enablers is required, too, to ensure that the underlying common systems are put in place.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

PJ.15 SESAR Solutions: Ground service oriented/open standardised technical architecture

- SESAR 1 PB04.05 D05 Business Model Services
- SESAR 1 PB04.05 D06 High Level Technical Architecture Service
- SESAR 1 PB04.05 D07 Action Plan Service
- SESAR 1 PB04.03 Working Method on Services
- SESAR 1 iSWIM Solution pack

In identifying and defining Common Services the Project will draw on many documents from the solution and enabling projects such as the OSEDs, SPR and INTEROPs, and the Business model and operational concept documentation and validation targets from the ATM Design Project (PJ19).

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

Source Project	Source Solution	PJ.15					
		PJ.15-01 Sub-regional Demand Capacity Balancing Service	PJ.15-08 Trajectory Prediction Service	PJ.15-09 Virtual Centre Service	PJ.15-10 Static Aeronautical Data Service	PJ.15-11 Aeronautical Digital Map Service	PJ.15-02 Delay Sharing Service
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB						▨
PJ.10 Separation Management En-Route and TMA	PJ.10-02A Improved Performance in the Provision of Separation		▨				
	PJ.10-01b Flight Centric ATC			▨			
PJ.18 4D Trajectory Management	PJ.18-06 Performance Based Trajectory Prediction		▨				
SESAR1	#46 Initial SWIM	▨	▨		▨	▨	▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

Source Project	Source Solution	PJ.01	PJ.04	PJ.09	PJ.10	PJ.11	PJ.18	
		PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB	PJ.04-02 Enhanced Collaborative Airport Performance Management	PJ.09-03 Collaborative Network Management Functions	PJ.10-02B Advanced Separation Management	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)
PJ.15 Common Services	PJ.15-01 Sub-regional Demand Capacity Balancing Service		▨	▨				
	PJ.15-02 Delay Sharing Service	▨						
	PJ.15-08 Trajectory Prediction Service	▨			▨		▨	
	PJ.15-10 Static Aeronautical Data Service					▨	▨	▨
	PJ.15-11 Aeronautical Digital Map Service							▨

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Dependencies with External Activities

None at the present time

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

The required expertise for each Common Service examined will be drawn from the following resources as required. Until the Service is further identified it is not possible to be more specific at this stage.

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management, runway environment…),
    - ATM Operational Experience (En Route, TMA, Network management, runway environment…),
    - ATC users requirements (ground & air),
    - Airspace users, airport operators and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System/Service:
    - System engineering, prototyping,
    - System development, service development
    - System Architecture, SOA, Cloud Based Architecture
    - ATM tools (Airport systems, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management and assurance,
    - Verification methodologies,

- Management and coordination:
  - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
  - Project management,
  - Quality management.
- Performance and Transversal Areas Assessments
  - Safety, security and environment performance measurement,
  - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
  - Technical expertise, knowledge and capabilities related to the European network as a whole,
- Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- Service Definition documentation per common service including
  - Service Specification including interface definition, quality of service, behaviour
  - Description of High Level Architectures for provider and consumer systems
  - Business Model and Cost Benefit Analysis
  - Service provider and consumer roles and responsibilities
  - Safety assessment and requirements
  - Security assessment and requirements
  - Proposed actions concerning rulemaking and standardisation
- Verification Reports for services and validation reports for business models
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned

C.16 Enabling Aviation Infrastructure – Controller Working Position / Human Machine Interface – CWP/HMI (PJ16)

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 need to be carefully addressed in supporting the operational, technical and human factors aspects. Notably a possible separation of some ATM Information Providers from ATM Business Services providers to go towards a 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.

In today’s situation ANSPs usually host a monolithic ATM system in each ATSU with very few information services and infrastructure elements being shared between the different centres.

In the Virtual Centre (VC) approach the Controller Working Positions are decoupled and may even be geographically separated from the ATM information services that they consume, and these ATM information services may be shared between different ATSUs or even between ANSPs. The main benefits expected from the Virtual Centre approach are cost reduction and more flexibility to support load-balancing between the participating ATSUs (as long as the participating ATSUs share a compatible VC operating concept).

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 shall be avoided as well as the use of non-user friendly interfaces.

A loosely related problem that needs to be addressed by this project is the need to identify means to increase the efficiency of using the CWP HMIs by exploiting the latest mature technologies. The project will thus be tasked with a transversal role related to HMI and human performance aspects. In this role, it will in particular need to investigate new HMI needs (response time, appearance and other characteristics) and interaction modes (touch, gesture, voice etc...) in relation to SESAR solutions and support the other ATM solution projects in integrating suitable new user interface technologies.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

The project deals with Operational and Technical objectives but neither addresses the “look & feel” aspects of the HMI, nor the development of complete CWP prototypes to support the operational validation of SESAR solutions, as these are managed by the relevant SESAR solution projects.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Virtual Centre Solutions (for Wave 1 and Wave 2)

This project will follow on from SESAR B.04.04 in developing the ATSU architecture from a service oriented approach with a focus on the technical services and common interfaces. Based on the 3 main objectives of the Virtual Centre concept, the CWP/HMI needs to interface with one or more information service providers or consumers. The definition of open standard interfaces for the CWP will facilitate the achievement of the Virtual Centre, validating:

- That CWPs, providing the human machine interface to the air traffic controller at the Air Traffic Service Units (ATSUs) for operating SESAR 1 solutions (and later SESAR 2020 solutions), are not negatively impacted by decoupling the CWP from the legacy ATSU systems.
- That ATM Data Service Providers (ADSPs) can be defined that host services for providing the necessary information to be consumed by CWPs in various geographically separated ATSUs, irrespective of the suppliers of ADSPs and CWPS.
- That open and standardised services (based on SWIM) can be defined to separate the application layer (the services provided by the ADSPs) and the presentation layer (the CWP/HMI)

The Virtual Centre solution is understood as an operating environment in which different Air Traffic Service Units, even across different ANSPs, will appear as a single unit although they may be spatially or organizationally separated. It has an associated Business Model and relies on a technical concept (will be described in the next paragraphs) in order to offer the required flexibility to operations.

The Virtual Centre approach requires operational and technical interoperability between the participating units (comparable operating concepts, allowing monitoring and dynamically balancing the workload between the different workstations). One of the key expected benefits that will prove the added value of the Virtual Centre operating concept will be the increase of efficiency and service continuity as it allows units (can be either one or several sectors or APP or TWR positions or even complete ATSU) to be closed and take over the control in another unit in case of low-traffic situations (e.g. at night) or in case of a unit failure.

Starting with the output from SESAR1 B.04.04, the project will define the architecture and the service interfaces of the Virtual Centre. The architecture needs to be applicable to ATSUs of different sizes (including TWR). The defined service interfaces aim at providing the technical means to ensure the separation between ATM Business service provision and ATM information provision. This separation can be seen as an important enabler of the Virtual Centre model. Compared to B.04.04, the project takes a more holistic perspective by covering all services, such as ATFCM, and voice communication in order provide a complete architecture for a Virtual Centre.

The scope of this project includes:

- The definition of an architectural model of the Virtual Centre.
- The definition of services (ready for standardization) between the ATSU/CWPs and ADSPs that can be used in the solution projects prototypes for validation and in VLDs. Technical realisation of the services will, as a target, be based on SWIM standards. New designed services/interfaces will be developed according to the Service Architecting process defined in PJ19 and in coordination with that same project. The service definition itself will be a joint development with the Data Centre Service for Virtual Centres common services solution.
- The development of prototypes to verify the Virtual Centre Architecture (and the defined interfaces). While early prototypes may only aim at verifying the ability of the proposed architecture and service interfaces to support the required service with the required flexibility and performance, these will need to be integrated with fully functional controller HMI prototypes that can be used in the validation exercises of solution projects and VLDs.
- The technical verification of the geographical separation of the ADSP services from the CWPs and local ATSU services, irrespective of the industrial suppliers of each of these elements, enforcing the split between the application layer (the underlying services provided by the ADSPs) and the presentation layer (the CWP/HMI) connected via an open standard interface, and cross validating between different providers.

Note: some of the above aspects are already being addressed in SESAR 1 Project B04.04 but due to the objectives of this project the coverage and depth of the analysis undertaken by B04.04 will be limited. For example B04.04 addresses a subset of CWP/ADSP services, performance aspects may not be investigated and the demonstrations will only aim at demonstrating the technical feasibility of decoupling certain selected services.

Common principles regarding the solution to be delivered are:

- Accessibility: ATSU/CWP can directly consume information using common service interfaces and network connectivity.
- Equity: No individual ATSU/CWP dominates, or constrains, what may be consumed, by other ATSUs/CWPs.
- Flexibility: Capability for adequate, responsive, timely, dynamic and asynchronous changes of providers and services they consume.
- Performance: Combined ATSU/CWP and infrastructure provisions must ensure required levels of performance, safety, and resilience, and provide effective incident and evolution management.
- Quality, Integrity & Security: Each service provider will have full responsibility for the quality, integrity, security, and availability of the information they provide and will need to be certified as a qualified provider for those services. Information will only be exchanged between such qualified parties and the necessary security measures will be applied.
- Cost: The solution will be designed with the objective to reduced investment and operating costs for the management and provision of the information.
- Service orientation: Service orientation methods are to be applied to support the ATC service provider definition.
- Open standards ATSU/CWP connection is expected to make use of applicable open and internationally recognised standards for the information, the content, the processes, and the provision of services.
- Global applicability: ADSP- ATSU/CWP services will need both international and local agreements, to achieve a seamless ATM information environment and therefore adequate governance needs to be established. The possible application of the virtual centre solution shall not be limited to the European region.

As indicated, this project will aim to design the virtual centre solution on the basis of SWIM Technical Infrastructure already developed as a solution in SESAR 1. The architectural analysis shall address finding a solution to support the non-functional requirements (NFR) of the Information Exchange Requirements (IER). The performance needs between the Virtual Centre and the ATM information services will need careful identification as the size of the information exchanged and the criticality of its timely and secure delivery could be significant (as they are supporting all the Air Traffic Control operations in the Virtual Centre). The amount of exchanges is also expected to be very high. A high performing and reliable underlying communication infrastructure may also be needed to support the needs identified and described for this solution.

Technical configuration, Supervision, Recording and Adaptation models shall not be addressed in the solution development but are expected to be covered as necessary in the context of the Wave 2 VLD project 2-3 Virtual Centre and other interested VLDs.

This solution encompasses ATSU/CWP and needed ATM system counterpart components for En-route and TMA environments and airport/TWR for the services that are relevant.

It shall be noted that in the first wave a first Virtual Centre solution shall be developed that supports ATM operations in line with the SESAR developed solutions. Validation of this solution will not address again the already mature SESAR 1 operational solutions but only the ability of the virtual centre solution to support the same operational performance using a different deployment of underlying systems and services. Assuming that the wave 1 solution development will be successful a follow-on virtual centre solution shall be developed In wave 2 that will be an integral part of the SESAR 2020 ATM solutions being developed then.

HMI evolution:

This solution will build on the output from SESAR1 projects 16.06.05, 16.04.02, 05.09, 06.09.02, 10.10.2 and 12.05.04. Considering that the look & feel and ergonomic aspects of the HMI are out of scope, the project will develop guidance and assessment methods regarding HMI (including investigation about HMI development processes to increase the productivity), will investigate new HMI needs and interaction modes in relation with SESAR solutions (including assessment of new user interface technologies e.g. speech recognition, multi-touch, gaze detection) and will develop mock-ups and prototypes for such areas to evaluate their feasibility. The project will focus on technologies and interaction modes that are regarded as sufficiently mature to be considered for V2 activities of the solution projects and support the other ATM solution projects in integrating these in their V2 validation platforms. Less mature technologies and HMI interaction principles are expected to be investigated through the application oriented Exploratory Research projects.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.16-03: Work Station, Service Interface Definition & Virtual Centre Concept

Solution Description:

As part of the on-going deployment discussions there is a possible scenario taking into account the possible out-sourcing of some ATM data services to information providers supporting multiple stakeholders. Enabling the possible delivery of such out-sourcing of ATM data services concept requires a clear industry standard interface to be determined in particular between the controller workstation and the related data services. The appropriate partitioning of the architecture and definition of the interface will need to take maximum advantage of Open architecture techniques as well as building on the work performed by B.04.04 and reviewed by B.04.03 on the decoupling of ATSU/CWP and FDP interfaces.

Defining the architecture of the future ATSU/CWP in order provide the technical means to validate the Virtual Centre concept via the separation between ATM Business service provision and ATM information Providers.

The starting point for developing this solution will be the set of ADSP/ATSU/CWP interfaces and services defined in SESAR 1 B.04.04. It contains, among others, the design of the data exchanged via Services in the CWP normal operations mode that must be enhanced in PJ16 in order to develop the Virtual Centre Concept. The following objectives will be achieved by this solution, including EN-ROUTE, TMA and TWR domains:

This first virtual centre solution shall be developed such that it supports ATM operations in line with the SESAR developed solutions. Validation of this solution will not address again the already mature SESAR 1 operational solutions but only the ability of the virtual centre solution to support the same operational performance using a different deployment of underlying systems and services.

Link with VLD projects :

2-3 VLD Virtual Centre: Operational demonstration of the virtual centre concept, implementing PJ16 services.

List of OI steps and enablers:

SOLUTION PJ.16-03 Work Station, Service Interface Definition & Virtual Centre Concept	Maturity				
	SESAR 1	SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
"Workstation, Service Interface Definition" for SESAR 1 scope	NA	V1	V2	V3	
Ground service oriented/open standardised technical architecture"	NA	V1	V2	V3	

SESAR Solution PJ.16-04: Workstation, Controller productivity

Solution Description:

This activity shall be driven by requirements for new innovative interaction needs captured from interactions between this project and the Solution Projects. This identification of needs will be done in the context of the assessment of the operational requirements coming from the interactions between this project and the Solution Projects.

As part of the productivity tools currently imagined for the improvement of the Controller Working Position, some are functional and are called smart tools. These tools will be addressed by the appropriate (PJ01 - PJ11) projects in SESAR2020. Some other possible improvements are new interaction features which are common to several/all SESAR2020 projects including an HMI. Hence it is proposed to validate the corresponding technologies in this project.

The solution shall select innovative interaction technologies that are already beyond maturity level V1 / TRL 2 and define and then run evaluations and demonstrations with involvement of operational users to investigate the possible benefits of the selected technologies to support V2 and/or V3 activities in SESAR 2020 solution projects. The quality criteria to take into consideration are human factors, safety, productivity improvements against current interaction means, and workload reduction.

Productivity in this project addresses especially the labour productivity which is usually expressed by controlled aircraft per hour or the amount of arrivals and departures. In general the productivity in industry is raised by increasing the automation. Increasing automation in ATC results in a timely increasing bundle of decision and negotiation support system functionalities. The ATCO is responsible for implementing all actions. To create the benefits from such automation the HMI is crucial for the productivity because it represents the last chain element of automation. Generating additional effort for the ATCO to provide information to different support systems is a worst case for the acceptance and productivity of such systems. The evolution of the HMI following the support system development has to be considered. This evolution has to be as well flexible and cost effective. Hence, HMI development and up-date processes have also to be taken into account to keep and enhance the ATCO’s productivity in a cost effective manner.

The introduction of electronic flight strips, or strip-less systems is accompanied by a significant change for ATCO working methods. At the same time modern controller support systems are getting operational. These systems must be kept "up to date" about what is happening in the sector which creates a burden for the ATCO who has to continually supply the system with input. . Conventional input techniques, for example via mouse or stylus, are reaching their limits (e.g. nested menus with long scroll areas etc.), especially under heavy traffic load and in conjunction with the expected extension of human-system collaboration. New interaction techniques and technologies need to be investigated and prototyped to minimise the load and mental strain on the controllers hence improving their productivity.

Among others, the following productivity solutions are intended to be tackled by this solution:

Multi-touch Input Devices:

Multi-touch input devices are widely used today and in the ATC world they have been subject of several prototypical implementations tested in simulation studies (see, e.g. SESAR 1 P10.10.02). The results indicate that multi-touch systems are in general suitable to overcome mental bottlenecks in the human-system interaction. In the present project, a proof-of-concept of the existing solutions shall be verified and validated in active R&D work including prototypical implementations that are iteratively tested and include representative data with regard to technical feasibility (TRL 3). These examinations shall also include Human Performance measurements in a relevant environment (above TRL 3).

Automatic Speech Recognition:

Automatic speech recognition (ASR) technology represents a promising way to keep the system up-to-date by using the controller input. As most input comes from the controller-pilot spoken dialog automatic speech recognition (ASR) is the appropriate technology to increase the productivity of controllers (or to reduce workload) by using the spoken commands as input to the system. On the other hand, the data base for all support tools is kept as updated as possible by taking into account the controller commands and as next step the spoken information coming from board by interpreting the pilot dialog also. In addition safety can be increased by using both, controller clearance and pilot read back to monitor if clearance and pilot read back does fit. The benefit for controller assistance was demonstrated exemplary in several projects. They demonstrated the feasibility in prototypical implementations validated at TRL 4 level. For example Voice Recognition and Response is already in use in ATC training at DFS. Also validated in operational tower environment to be used as input source to feed the tower FDPS in order to reduce head down times of the controller. In the present project, the implementations could be extended to other controller working positions and support tools.

Attention Guidance:

The ATCOs' attention is the central bottleneck in the human-system interaction as they can only attend to a limited number of events at a time. Modern gaze detection systems provide distant measurement and thus can be used for assessing and improving the attention of ATCOs without interfering with their tasks. With increasing automation the amount of information presented on controllers HMI will increase, too. As ATCOs' productivity is to be kept high in cases of alerts and exceptional situation it will be useful to guide their attention. Capturing ATCOs' eye movements can be used as an input mechanism to drive the human-system interaction and thus increase their productivity. Eye gaze systems can assess and guarantee the quality of their attention by assessing the real-time monitoring and vigilance of the human operator. Furthermore eye gaze analysis could enable single operator working conditions (for instance remote or in a virtual centre) by building a safety envelope around the HMI. In the present project, the feasibility of gaze detection deployment for attention control could be shown at TRL level 5.

User Profile Management Systems:

To increase CWP productivity new technologies for the User Profile Management Systems (UPMS) shall be investigated to identify/authenticate the controller wherever he sits in the virtual centre. Prototypical implementations shall be validated at TRL level 5. As add-on these technologies provide the basis for an individualisation of CWP/HMI elements fostering the productivity of the ATCO. For example the CWP/HMI can be equipped with a speech recognizer that identifies an individual speaker by interpreting voice characteristics. Other technologies like finger print, iris, or face recognition are alternatives that can be used for individual authentication. A multimodal biometric authentication can be created by combining several technologies also usable for other CWP/HMI applications.

Efficient Development Process:

Besides taking into account the specific requirements resulting from different operational techniques, ATCO tasks, and organizational needs, the solution should explore modern engineering methodologies and software technologies with a maturity level equivalent to at least TRL 3. Since the workstation software will be subject to lifelong changes even after commence of operation, the solution should demonstrate how such technologies can be exploited to maintain ATCO productivity by ensuring smooth changes as minimal invasive as possible. This particularly applies to a consistent way information presentation and ATCO interaction with the system.

Qualification of CWP virtualisation/thin client technologies fit for ATC purposes

This solution aims at assessing client virtualisation and thin clients technologies that can be used for safety critical HMI for ATC. In addition such technologies are recognised to be significant contributors in term of maintenance cost reduction. It will include the assessment of available technologies compared to safety and performance constraints, the development of prototypes using such technologies and their assessment, and finally it will provide guidance and recommendations for solution projects and VLD projects related to the usage of such technologies for ATC purpose (e.g. Virtual centre implies the idea of a certain agility in terms of deployment, services can be deployed remotely, in data centres, etc.. However, little have being done for the client side). This topic was not covered in SESAR 1 and is an opportunity for the current project to investigate.

Generally speaking the goal of these investigations and prototyping activities is to test novel user interaction principles in this project that can then be proposed to some relevant solution projects in particular to be integrated in the context of V2 and/or V3 validation activities.

The most obvious solution projects that could potentially benefit from such outputs of PJ16 for their V2/V3 activities include projects PJ01, PJ02, PJ03A, PJ03b, PJ05, PJ06, PJ10 and PJ18. These dependencies are described in the next sections. Besides, VLDx-7 and VLDx-3 are candidates to also benefit from the outcome of this solution.

The solution shall consider inputs from SESAR1: P10.10.02, P12.05.04 and WPE.

List of OI steps and enablers:

NOTE: Solution PJ.16-04 will prototype a set of user interaction features and technologies that the ATM Solution Projects may then decide to adopt and possibly integrate in their validation platforms in order to achieve their associated OIs especially with respect to their controller productivity objectives. With this consideration Solution PJ.16-04 could be understood as a set of transversal Enablers that support the achievement of several OIs for several ATM Solution Projects (those indicated in the "Dependencies" section).

SOLUTION PJ.16-04 Workstation, Controller productivity	Maturity				
	SESAR 1	SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
To be identified	V1		V2	V3	

NOTE : the list of enablers for this solution will be defined in the frame of DS15.

Performance Goals

Assuming that the infrastructure performance in terms of security, data integrity, response time, latency etc. is met, the development of the Virtual Centre will support the achievement of the following performance objectives:

- Increased safety
- Increased ATCO efficiency

- Increased capacity
- Improved resilience
- Improved HMI and usability and performance of interactions
- Improved interoperability in Airports, TMA and En-Route domains

The objectives of supporting the definition of the associated Business Services (and the corresponding technical services and interfaces) to enable the Virtual Centre (and decoupling 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

	Capacity	Efficiency	Predictability	Flexibility	Safety	Human Performance	Security	Environmental Sustainability	Access and Equity	Participation	Interoperability	Cost effectiveness
SOLUTION PJ.16-03 **Work Station, Service Interface Definition & Virtual Centre Concept**	H	H			M	M		L	M			H
SOLUTION PJ.16-04 **Workstation, Controller productivity**	**M**	**M**	**M**	M	**H**	**H**		**M**			M	**H**

Note that this project primarily addresses the technical services and interfaces and that the elicitation of the Business Services will be coordinated with PJ15.

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.16-03 **Work Station, Service Interface Definition & Virtual Centre Concept**	L/N	The solution aims primarily at enabling cross-border Virtual Centre implementations but may also offer benefits for local implementations
SOLUTION PJ.16-04 **Workstation, Controller productivity**	L/N	The solution aims to increase the ATCOs productivity by developing and integrating new interaction possibilities taking into account an effective development process.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

SESAR Solution PJ.16-03: Work Station, Service Interface Definition & Virtual Centre Concept

- SESAR 1 PB04.04 D03 Refinement of operational model
- SESAR 1 PB04.04 D07 Service A-Z : Service allocation - Design and Interface definition
- SESAR1 iSWIM solution pack

SESAR Solution PJ.16-04 Workstation, Controller productivity

- SESAR 1 P10.10.02 material on controllers productivity technologies/tools
- SESAR 1 P12.05.04 material on controllers productivity technologies/tools
- SESAR 1 WPE material on technologies that could increase controllers productivity

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.16	
Source Project	Source Solution	PJ.16-04 Workstation, Controller productivity	PJ.16-03 Virtual Centre concept
PJ.01 Enhanced arrivals and departures	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	▨	
	PJ.01-03 Dynamic and Enhanced Routes and Airspace	▨	
PJ.02 Enhanced Runway Throughput	PJ.02-02 Enhanced arrival procedures	▨	
PJ.05 Remote Tower for Multiple Airports	PJ.05-02 Remotely Provided Air Traffic Service for Multiple Aerodromes	▨	
	PJ.05-03 Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules	▨	
PJ.06 Trajectory Based Free Routing	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	▨	
	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace	▨	
PJ.09 Advanced DCB	PJ.09-03 Collaborative Network Management Functions	▨	
PJ.10 Separation Management En-Route and TMA	PJ.10-01a High Productivity Controller Team Organisation	▨	▨
	PJ.10-01c Collaborative Control	▨	▨
	PJ.10-02A Improved Performance in the Provision of Separation	▨	▨
	PJ.10-02B Advanced Separation Management	▨	▨
	PJ.10-05 IFR RPAS Integration	▨	
	PJ.10-01b Flight Centric ATC	▨	▨
PJ.14 CNS	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing		▨
PJ.17 SWIM Infrastructures	PJ.17-02 SWIM TI Federated Identity Management		▨
SESAR1	#05 Extended Arrival Management (AMAN) horizon		▨
	#11 Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO)		▨
	#19 Automated support for Traffic Complexity Detection and Resolution		▨
	#27 MTCD and conformance monitoring tools		▨
	#28 Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing		▨
	#32 Free Route through the use of Direct Routing		▨
	#33 Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level		▨
	#46 Initial SWIM		▨
	#58 Display and use of ACAS resolution advisory downlink on the controller working position		▨
	#63 Multi Sector Planning		▨
	#67 AOC Data Increasing Trajectory Prediction Accuracy		▨
	#69 Enhanced STCA with down-linked parameters		▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.01		PJ.02		PJ.05		PJ.06		PJ.07	PJ.09	PJ.10					
Source Project	**Source Solution**	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	PJ.01-03 Dynamic and Enhanced Routes and Airspace	PJ.02-02 Enhanced arrival procedures	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.05-02 Remotely Provided Air Traffic Service for Multiple Aerodromes	PJ.05-03 Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules	PJ.06-01 Optimized traffic management to enable Free Routing in high and very high complexity environments.	PJ.06-02 Management of Performance Based Free Routing in Lower Airspace	PJ.07-01 AU Processes for Trajectory Definition	PJ.09-03 Collaborative Network Management Functions	PJ.10-01a High Productivity Controller Team Organisation	PJ.10-01c Collaborative Control	PJ.10-02A Improved Performance in the Provision of Separation	PJ.10-02B Advanced Separation Management	PJ.10-05 IFR RPAS Integration	PJ.10-01b Flight Centric ATC
PJ.16 CWP - HMI	PJ.16-04 Workstation, Controller productivity	▨	▨	▨	▨	▨	▨	▨	▨		▨	▨	▨	▨	▨	▨	▨
	PJ.16-03 Virtual Centre concept									▨							

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Dependencies with External Activities

None at the present time

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

It is anticipated that service interfaces developed in this project and the VLD on Virtual Centre will provide a basis for a standardisation by a standardisation body such as EUROCAE.

This project is expected to coordinate as required with e.g. EUROCAE for the creation of, and contributions to, the relevant standardisation activities on the basis of the work done in Wave 1.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Network management, runway environment…),
    - ATM Operational Experience (En Route, TMA, Network management, runway environment…),
    - ATC users requirements (ground & air),
    - Airspace users, airport operators and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (Airport systems, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;

    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
    - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- VCM Operating Concept.
- Minimum requirements for operational interoperability between different ATSUs operating in a virtual centre configuration.
- ADSP/CWP Interface Requirements Specification.
- ADSP/CWP Interface services and data models.
- Technical Specifications for the HMI Technical Enablers.
- Verification Reports for the ADSP/CWP Interface Requirements Specification.
- Verification Reports for the Technical Specifications of the HMI Technical Enablers.
- Technical Validation and Evaluation Report of VCM Operating Concept.
- Technical Validation and Evaluation Reports of innovative HMI Technologies.
- Communication Plans and results.

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.17 Enabling Aviation Infrastructure – SWIM Infrastructure (PJ17)

PJ.17	**SWIM Infrastructures**

Problem Statement

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

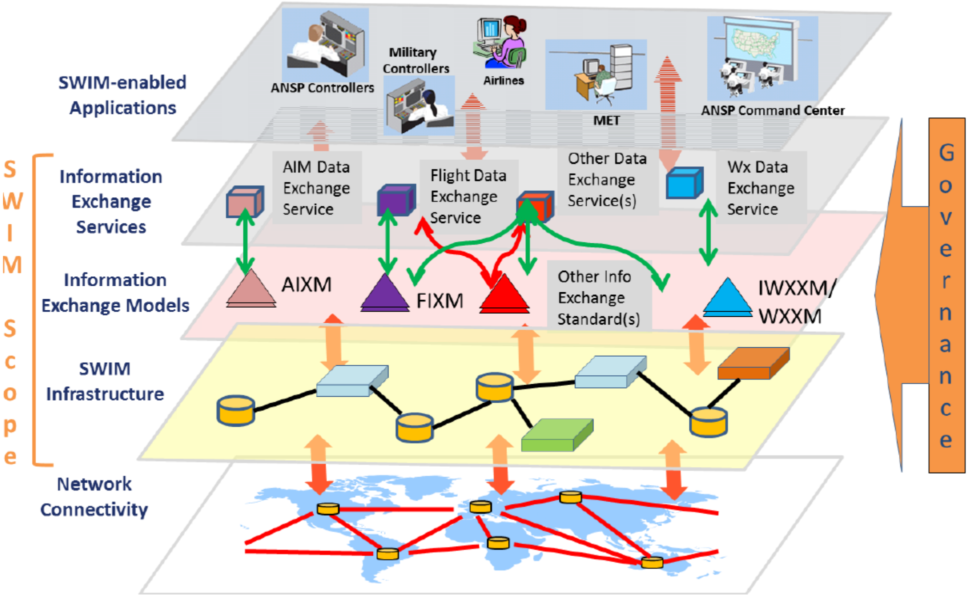

Figure 1: SWIM Infrastructure in the SWIM Interoperability Framework

From the SESAR 1 programme it is expected that in the domain of SWIM infrastructure three mature solutions will already be available (the yellow and blue profile SWIM technical infrastructure solutions, which include a standardized function related to identity management/authentication, and the SWIM design time Registry), while a further solution, the SWIM TI purple profile for advisory services, will have reached V2.

Further work is required to mature and validate SWIM A/G solutions for advisory services and for safety critical services, federated identity management, a common runtime registry and civil-military interoperability.

The Project has also to contribute to SWIM related activities dealing with standardisation, governance, registry, cybersecurity, communication infrastructures (e.g. ATN/IPS), V & V, etc.

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

Two solutions will be developed for what is known in SESAR 1 as the SWIM TI Purple Profile (ref. to Projects description PJ.17-01 and PJ.17-07)

The first area of development to be addressed in this project will be the further development of the SWIM "Purple" Profile. The SWIM Purple Profile addresses the SWIM A/G infrastructure necessary to support ATM operational improvements that depend on A/G information exchanges to enable better situational awareness and collaborative decision making.

In this area, two specific solutions will be developed. The first solution, which has already been developed to the equivalent of V2 SESAR 1, addresses the purple SWIM TI profile to support A/G SWIM advisory services. The second solution will be an enhanced purple SWIM TI profile that supports operational, safety and performance requirements necessary for safety-critical A/G services.

SWIM TI Federated Identity Management (PJ.17-02) and SWIM TI Common runtime registry (PJ.17-08)

In SESAR 1, a number of Functional Blocks (i.e., high level functionalities, as defined in TAD and TSs) have been considered as "shareable" (i.e., SWIM-TI functions whose realization could be performed once for the benefit of several function users and be used by other SWIM-TI functions from various SWIM profiles).

In particular, no prototypes implementing Identity Management and Run-Time Registry Technical Specifications have been developed in SESAR 1. Nevertheless, it must be stated that SESAR 1 prototypes did actually implement Security related functionalities (as Blue and Yellow Profiles specify such features as well). Anyway, such prototypes didn't include advanced Security features relying on such Shareable functions such as (Federated) Identity Management and Run-Time Registry (e.g., for storage and/or retrieval of security policies).

SWIM TI Green Profile for G/G Civil-Military information sharing (PJ.17-03)

The third topic relates to the civil-military interoperability supporting the information sharing between the Military ATC/AD networks and civil SWIM technical infrastructure.

It is envisaged that a new SWIM Profile for SWIM G/G Civil-Military interoperability may need to be defined as well. This possibility will be investigated during wave 1. The feasibility to reach "full" V3 maturity for this (possible) new SWIM Profile or "just" for a portion of it within wave 2 will have to be estimated.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber Security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.17-01: SWIM TI Purple Profile for Air/Ground Advisory Information Sharing

Solution Description:

Building on the Purple Profile specification produced during SESAR 1, and matured to V2 level, there is a need to continue the development of this solution to V3 maturity. This solution will use the SESAR 1 results with respect to the SWIM Technical Infrastructure (mainly from SESAR1 09.19 and WP14) and will further develop the SWIM Technical Infrastructure for air to ground and ground to air sharing of advisory (non-safety-critical) information. It is aimed to deliver a mature SWIM TI purple profile solution for advisory services in Wave 1.

The confirmation of the functional and performance requirements for this solution, identified so far in SESAR 1, will be expected from other SESAR 2020 solution projects that require A/G advisory information exchanges using SWIM.

This Solution will be defined using the following artefacts (from a high level perspective):

- Specification of technical architecture and functions that are required to achieve full interoperability between air and ground SWIM segments and meet the safety and performance requirements required by airborne operations.
- Verification Plans and Reports that demonstrate that prototypes are meeting the requirements.

In order to deliver the solution material as defined above, the following activities are expected to be considered:

- Analysis of, and coordination with ATM Solution projects which will be providing Service Description Documents (SDDs) as they might set (or imply) A/G advisory information exchange requirements (e.g., expectations in terms of NFRs) on the underlying SWIM Infrastructure.
- Definition of both Functional and Non-Functional Requirements (NFRs) on the A/G technical infrastructure, including security, performance, safety, accessibility, maintainability and reliability requirements.
- Definition and verification of the necessary compliance to relevant air-ground interoperability specifications and compatibility between relevant SWIM infrastructure solutions.
- Definition of Security Controls required for protecting the airborne and ground SWIM assets.
- Development of prototypes of necessary SWIM Air-Ground Technical Infrastructure to the required maturity level to support validations with one or more different technical architectures. It is foreseen that this solution will mainly exploit existing information technology standards and that prototypes will mainly be derived from COTS products.
- Supporting the integration of the above solutions with other SESAR 2020 projects demanding such functionalities requiring them in validation exercises. The integration support could be required either in terms of “Software Integration”, or in terms of “System Engineering”.
- Development of methods, stubs (if needed) and tools (including the test tools) for the infrastructure testing and infrastructure related problems diagnosis (e.g., tools for load/functional testing)
- Specifying interface requirements on the underlying IP communication infrastructure (e.g., for network-level security and mobility network etc.). Such requirements will have to be shared/communicated with relevant PJ14 Solutions.

NOTE: This is an advisory (non-safety-critical) system. The requirements in support of safety critical A/G information exchange will be analysed in a second wave (see PJ.17-07).

- Provision of possible updates to/evolution of SWIM Technical Infrastructure Profile Compliance Criteria for the Purple Profile (in cooperation with PJ19)
- Assessment on feasibility (and cost) to achieve required assurance levels. This may include discussions with relevant agencies (e.g., EASA).
- Provide support for standardisation of the “Purple Profile for advisory services”.
- Global coordination ensuring interoperability of the SESAR A/G SWIM solution with the FAA Aircraft Access to SWIM (AAtS) and other global SWIM Technical Infrastructures and analysis, design and (if required) implementation of architectural elements that might be further needed to ensure such global interoperability.

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SESAR Solution PJ.17-01
SWIM TI Purple Profile for Air/Ground Advisory Information Sharing</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><th rowspan="2">Maturity Level at the end of SESAR 1</th><th colspan="3">Wave 1</th><th rowspan="2">Wave 2</th></tr>
<tr><th>R6</th><th>R7</th><th>R8</th></tr>
<tr><td>IS-0901-B "SWIM for Step2"
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>AGSWIM-34</td><td>New System AGDLGMS</td></tr><tr><td>A/C-57</td><td>Onboard migration from existing air-ground data link to air-ground SWIM for AIS/MET services</td></tr><tr><td>SWIM-SUPT-03b</td><td>SWIM Supporting Security</td></tr><tr><td>SWIM-STD-01b</td><td>ATM Information Reference Model</td></tr></table></td><td>NA</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
</table>

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SESAR Solution PJ.17-02: SWIM TI Federated Identity Management

Solution Description:

In SESAR 1, a number of Functional Blocks (i.e., high level functionalities as defined in TAD and TSs) have been considered as “shareable” (i.e., SWIM-TI functions whose realization could be performed once for the benefice of several function users and be used by other SWIM-TI functions from various SWIM profiles.

The SESAR 1 SWIM TI Yellow and Blue Profile Solutions depend on a common solution related to federated identity management. This common solution will not reach the equivalent of V3 in SESAR 1 and will need further evolution in SESAR 2020 to reach the required maturity level.

In SESAR 1 Security features have been specified in P14.1.4 and 14.2.2 in several iterations taking into account the results of SWIM security risk assessments and application of security best practices.

While developing this solution, the following aspects will need to be considered as well:

- Support on the integration of this solution with other SESAR 2020 projects demanding such functionality for execution of validation exercises. The integration support could be required both in terms of “Software Integration” and “System Engineering”.
- Provide SESAR prototypes to apply federated identify management in support of validations with one or more different technical architectures.
- Specification of requirements on the underlying communication infrastructure (e.g. Network Connectivity requirements for PENS, for mobility network etc.). Such requirements will have to be shared/communicated with relevant PJ14 Solutions.
- Support for Standardisation of “federated identity management” included in this solution.
- Global coordination ensuring interoperability between global SWIM Technical Infrastructures and analysis, design and (if required) implementation of architectural elements that might be further needed to ensure global interoperability (e.g., between non-European Registries, SWIM Security solutions defined in non-SESAR initiatives etc.).
- Estimate according to a cost-benefits analysis the PKI detailed features as architecture, modularity, scalability and models of trust.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SESAR Solution PJ.17-02
SWIM TI Federated Identity Management</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>IS-0901-B SWIM for Step2
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>SWIM-SUPT-01b</td><td>SWIM Supporting Registry</td></tr><tr><td>SWIM-SUPT-03b</td><td>SWIM Supporting Security</td></tr></table>.</td><td>NA</td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
</table>

SESAR Solution PJ.17-03: SWIM TI Green Profile for G/G Civil Military Information Sharing

Solution Description:

There may be interoperability and security aspects to be addressed when military systems are to access SWIM. With respect to interoperability, there may be a need to ensure that the protocols and data models used in military systems can be interfaced with SWIM with the adequate quality of service levels maintained.

This solution development shall start with the identification and agreement of requirements specifying such needs in more detail before developing any TS and/or prototypes.

Military ATM and AD/C2 networks already use civil ATM information to ensure their legitimate National defense and security missions. One objective of this solution is to enhance the exchange of Air Traffic Management (ATM) information between civil and military parties. The concept of Single European Sky requires the military to provide new information exchange to civil ATM, until now considered restricted to the unique usage of military ATM and AD/C2. To support bi-directional information exchange between the military networks and civil ATC networks several countries currently develop Military Information Exchange Gateways (IEG) that addresses the protection of classified military data.

These IEGs are designed for information exchange between networks of different classification level, protection against cyber-attack and to support "Common Criteria" defined by Military security bodies for certification procedures. These IEGs could be interfaced with the SWIM Technical Infrastructure (SWIM TI) in order to support all information exchange requirements as identified in SESAR 1 as also described in ad hoc SESAR1 study, performed in the context of P14.01.03 project, which produced the following documents on SWIM Civil-Mil Interoperability Study:

1 D1 - Characteristics of Military ATM and AD/C2 systems and the justification for their interoperability with SWIM
2 D2 - Target SWIM Interoperability Concept and Architecture
3 D3 - Detailed technical civil-military SWIM interoperability requirements
4 D4 - Prototyping and V&V Plan

All required civil-military Information exchanges are described in those documents. The security issues were analysed mainly in the document D1 chapter 4.

In the "EUROCONTROL **Roadmap on Enhanced civil-Military CNS Interoperability and Technology convergence. Ed. 2**", produced Oct 2013, the requirements have been expressed for the interoperability of military systems with civil SWIM solutions.

Military ATM and Air Defence/C2 system connectivity interface with SWIM can be based on an IEG or any other alternative validated in the national military environment with bi-directional Information Exchange between the networks of different security domains. SWIM Technical infrastructure solutions to support the exchange are predominantly based on common IT technology and organized in so-called SWIM Profiles.

The advantage of the IEG model is to solve interoperability mismatches and allow a double administration of security, i.e. one administration for each of the two interconnected networks. The use and configuration is described in detail in multiple NATO documents. Such interface will have to be formally accredited by the proper certification bodies.

The military will interact with civil SWIM services only if two conditions are met. Firstly, if the military are able to apply their own security policy. Secondly, if the military have confidence in the enforcement of appropriate security controls in the civil SWIM enabled systems.

In any case, without prejudice to internal SWIM security measures, the overall definition, accreditation and management of security mechanisms and practices associated with a node interconnecting a military system to SWIM shall remain primarily under the ownership and supervision of military authorities.

Considering that the IEG (or other accredited solution) design and development will be under the responsibility of Military, outside of SESAR 2020, coordination will be required with PJ.17 on solution PJ.17-03.

ACTIVITIES PLAN FOR PJ.17-03

The activities foreseen to deliver this SESAR 2020 solution are expected to encompass:

- Analysis of the service definitions coming from SESAR 2020 solution projects that support information exchanges between civil and military stakeholders. A non-exhaustive provisional list of projects where such services may be defined is:
    - Optimized Airspace users operations (PJ.07)
    - Advance Airspace Management (PJ.08)

  - Surveillance (PJ.14)
  - 4D Trajectory management (PJ.18)
- Analysis whether the SESAR 1 solutions for SWIM TI Yellow and Blue profile, will allow the development of the IEG by the military in support of such services, or whether a specific SWIM TI Green Profile for G/G Civil Military Information Sharing will be required.
- Possible definition activities for specification of a 'Green' SWIM TI Profile, which include the integration in the overall TAD for SWIM Technical Infrastructure in collaboration with PJ19
- Development of specific prototypes of the Green profile SWIM TI for use in validation activities by the aforementioned operational solution projects in collaboration with programme external military projects.
- Possible provision of such prototypes for use in VLD activities in Wave 2

This Solution will be defined using the following artefacts (from a high level perspective):

- Specification of technical architecture and SWIM TI functions, which are required for the SWIM TI Green Profile.
- Verification Plans and Reports that demonstrate that prototypes are meeting the requirements.

List of OI steps and enablers:

SESAR Solution PJ.17-03 SWIM TI Green Profile for G/G Civil Military Information Sharing	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
IS-0901-C "SWIM for Step3"					V1-V2 V3:Beyond 2020

Enabler Code	**Enabler Title**
GGSWIM-51c	SWIM Ground-ground messaging services in Step3
GGSWIM-57c	Ground-ground data services for ATFCM using SWIM in Step3
GGSWIM-10c	SWIM Supervision for Step3
GGSWIM-58c	SWIM registry in Step3
GGSWIM-59c	SWIM security in Step3
GGSWIM-60c	Provision of Ground-ground data SWIM enabled services for Network Operations Planning available in Step3
GGSWIM-62c	Use of Ground-ground data SWIM enabled services for Network Operations Planning available in Step3
GGSWIM-63c	Provision of ground-ground SWIM enabled services for aeronautical information distribution available in Step3

GGSWIM-64c	Use of ground-ground SWIM enabled services for aeronautical information distribution available in Step3					
GGSWIM-65c	Use of ground-ground SWIM enabled services for flight information exchange available in Step3					
GGSWIM-66c	Provision of ground-ground SWIM enabled services for weather information exchange available in Step3					
GGSWIM-67c	Use of ground-ground SWIM enabled services for weather information exchange available in Step3					

SESAR Solution PJ.17-08: SWIM TI Common runtime registry

Solution Description:

In SESAR 1, the SWIM registry related activities have focussed on a design-time registry. Even if initial P14.1.4 specifications exist, a run-time registry solution was not expected to be matured in SESAR 1. A Run-Time registry is usable for dynamic binding to services, provision of routing information to services, provision of service status information and lookup of policies. Therefore, the work expected to be performed in SESAR 2020 about Run-Time Registry will have to deal with:

- Analysis of standards and technologies
- Definition of the interfaces for publication, lookup, management and network of registries
- Definition of non-functional requirements such as, for instance, performance and availability
- Design, definition and experimentation of distinct topologies (including federation of distinct run-time registries)
- Provide SESAR prototypes of runtime registries in support of validations with one or more different technical architectures
- Support on the integration of this solution with other SESAR 2020 projects for execution of (technical) validation exercises. The integration support could be required both in terms of “Software Integration” and “System Engineering”
- Support for Standardisation of “runtime registry service” included in this solution
- Global coordination ensuring interoperability between Registries.

List of OI steps and enablers:

<table>
<tr><td rowspan="4">SESAR Solution PJ.17-08
SWIM TI Common runtime registry</td><td colspan="5">Maturity</td></tr>
<tr><td>SESAR 1</td><td colspan="4">SESAR 2020</td></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
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<tr><td>IS-0901-B "SWIM for Step2"
<table><tr><th>Enabler Code</th><th>Enabler Title</th></tr><tr><td>SWIM-SUPT-01b</td><td>SWIM Supporting Registry</td></tr><tr><td>SWIM-SUPT-03b</td><td>SWIM Supporting Security</td></tr></table>.</td><td></td><td>V1</td><td>V2</td><td>V3</td><td></td></tr>
</table>

SESAR Solution PJ.17-07: SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing

Solution Description:

So far, CPDLC and ADS-C ATM services are used for point-to-point exchange of safety-critical data between aircraft and ground ANSP systems. The "Purple Profile for Air/Ground Safety-Critical Information Sharing" solution will focus on distribution of safety-critical information through A/G SWIM infrastructure and ATN/IPS networking, rather than legacy point-to-point contracted services.

As an example, ADS-C style services (either continental or oceanic) may take advantage of aircraft using an information publication method over A/G SWIM infrastructure with several ANS (and possibly AOC) systems subscribing to this information over the Ground SWIM infrastructure.

As a prerequisite, the operational solution projects (e.g. PJ11) need to specify Operational Services and Environment Definitions (OSED) and associated Operational and Safety Performance Requirements (SPR) for such information sharing methods that may require major updates to actual standards (and regulations in Europe).

This solution is expected to complement the Air/Ground SWIM Purple Profile for advisory services. Specifications will have to be defined to support safety and security requirements allowing exchange of safety critical information (It will need to be identified whether the specification of this solution for safety critical services will be dependent on the solution for advisory services or whether it will be described as a stand-alone solution).

The nature of the activities required to develop the Purple Profile for safety critical services is basically the same as for solution PJ.17-01, except that for this solution the work has to start at V1 level and that safety requirements will play a more important role.

This Solution will be defined using the following artefacts (from a high level perspective):

- Specification of technical architecture and functions that are required to achieve full interoperability between air and ground SWIM segments and meet the safety and performance requirements required by airborne operations.
- Verification Plans and Reports that demonstrate meeting the requirements.

In order to deliver the solution material as defined above, the following activities are expected to be considered:

- Analysis of, and coordination with ATM Solution projects which will be providing Service Description Documents (SDDs) as they might set (or imply) A/G safety critical information exchange requirements (e.g., expectations in terms of NFRs) on the underlying SWIM Infrastructure.
- Definition of SWIM TI Functional and Non-Functional Requirements (NFRs) on the A/G service infrastructure, including security, performance, safety, accessibility, maintainability and reliability requirements, starting from the existing requirements for e.g. CPDLC and ADS-C services.
- Definition and verification of the necessary interoperability between safety critical air and ground systems, compliance to relevant interoperability specifications and compatibility between relevant SWIM infrastructure solutions.
- Definition of Security Controls required for protecting the airborne and ground SWIM assets for the safety critical A/G systems.
- Development of prototypes of necessary SWIM Air-Ground Technical Infrastructure for the safety critical information sharing systems to the required maturity level to support validations with one or more different technical architectures. It is foreseen that also this solution will mainly exploit existing information technology standards and that prototypes will mainly be derived from COTS products.
- Supporting the integration of the above solutions with SESAR 2020 projects demanding such functionalities for use in their validation exercises. The integration support could be required either in terms of “Software Integration”, or in terms of “System Engineering”.
- Development of methods, stubs (if needed) and tools (including the test tools) for the infrastructure testing and infrastructure related problems diagnosis (e.g., tools for load/functional testing)
- Specifying interface requirements on the underlying IP communication infrastructure (e.g., for network-level security and mobility network etc.).
- Provision of possible updates to/evolution of SWIM Technical Infrastructure Profile Compliance Criteria for the Purple Profile (in cooperation with PJ19) or the creation of a new profile for safety critical A/G information exchange.
- Assessment on feasibility (and cost) to achieve required assurance levels. This may include discussions with relevant agencies (e.g., EASA).
- Provision of support for standardisation of the “Purple Profile for safety critical services”.
- Global coordination ensuring interoperability of the SESAR A/G SWIM-safety critical data sharing solution with the FAA Aircraft Access to SWIM (AAtS) and other global SWIM Technical Infrastructures and analysis, design and (if required) implementation of architectural elements that might be further needed to ensure such global interoperability.

List of OI steps and enablers:

SESAR Solution PJ.17-07 SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing	Maturity				
	SESAR 1	SESAR 2020			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
IS-0901-C "SWIM for Step3"	NA				V1-V2-V3 V3: Beyond 2020

IS-0901-C "SWIM for Step3"

Enabler Code	Enabler Title
AGSWIM-35	Flight Data updates transmitted by AGDLGMS to the Aircraft
AGSWIM-36	Flight Data dialogues supported by AGDLGMS
AGSWIM-37	Flight Data updates made by the aircraft leading to ground shared flight data updates
AGSWIM-38	SWIM enabled services for AGDLGMS
A/C-31d	Uplink of clearances or instructions beyond step 3 (IP3)
ER APP ATC 132	Transition ER and APP ATC systems from use of direct AGDL connection to use of European gateway.
GGSWIM-58c	SWIM registry in Step3
GGSWIM-59c	SWIM security in Step3

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Performance Goals

SWIM Technical Infrastructure performance shall be aligned with the needs of operational activities.

In particular for Solution PJ17-01 (Purple Profile implementation) Cost Efficiency of operating air/ground communication systems are expected to be greatly improved.

	Capacity	Cost Effectiveness	Fuel Efficiency	Predictability	Safety
SOLUTION PJ.17-01 **SWIM TI Purple Profile for Air/Ground Advisory Information Sharing**	**M**	**H**		**M**	**M**
SOLUTION PJ.17-02 **SWIM TI Federated Identity Management**		**H**			
SOLUTION PJ.17-03 **SWIM TI Green profile for G/G Civil Military Information Sharing**	**M**	**M**			
SOLUTION PJ.017-07 **SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing**	**M**	**H**			**M**
SOLUTION PJ.17-08 **SWIM TI Common runtime registry**		**M**			

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on A/G integration in perspective of future deployment (e.g., addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.17-01 **SWIM TI Purple Profile for Air/Ground Advisory Information Sharing**	**N**	SWIM requires by definition coordination and synchronization among different stakeholders. For details on the expected links with other SESAR2020 Projects as well as other external activities please see the respective sections below.
SOLUTION PJ.17-02 **SWIM TI Federated Identity Management**	**N**	SWIM requires by definition coordination and synchronization among different stakeholders. For details on the expected links with other SESAR2020 Projects as well as other external activities please see the respective sections below.
SOLUTION PJ.17-03 **SWIM TI Green Profile for G/G Civil Military Information Sharing**	**N**	SWIM requires by definition coordination and synchronization among different stakeholders. For details on the expected links with other SESAR2020 Projects as well as other external activities please see the respective sections below.

SOLUTION PJ.017-07 **SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing**	**N**	SWIM requires by definition coordination and synchronization among different stakeholders. For details on the expected links with other SESAR2020 Projects as well as other external activities please see the respective sections below.
SOLUTION PJ.17-08 **SWIM TI Common runtime registry**	**N**	SWIM requires by definition coordination and synchronization among different stakeholders. For details on the expected links with other SESAR2020 Projects as well as other external activities please see the respective sections below.

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

SESAR Solution PJ.17-01: SWIM TI Purple Profile for Air/Ground Advisory Information Sharing

SESAR Solution PJ.17-07: SWIM TI Purple Profile for Air/Ground Safety-Critical Information Sharing
- SESAR1 P14.01.03 D38 SWIM Profiles for Step 3 - Iteration 3.1
- SESAR1 P14.01.03-D35 SWIM Architectural Definition for Iteration 3.0
- SESAR1 14.01.04.D43-001 SWIM-TI Technical Specifications Catalogue 3.0
- SESAR1 P14.01.04 D43-002 SWIM-TI Identity Management Technical Specification 3.0
- SESAR1 P14.01.04 D43-003 SWIM-TI Run Time Registry Technical Specification 3.0
- SESAR1 P14.01.04 D43-004 SWIM-TI Yellow Profile Technical Specification 3.0
- SESAR1 P14.01.04 D43-005 SWIM-TI Blue Profile Technical Specification 3.0
- SESAR1 P14.01.04 D43-006 SWIM-TI Purple Profile Technical Specification 3.0
- SESAR1 P14.02.02 D26 -- SWIM security spec-design iteration 3.1
- SESAR1 P09.19-D03-002 -- SWIM A-G requirement specification and high-level system architecture definition version 2
- SESAR1 P09.19-D07 -- SWIM A-G System Architecture Functional Specification and Technical Requirement Specification - version 2
- SESAR1 P09.19-D29 -- SWIM A-G Concept of Operations
- SESAR1 P09.19-D05 -- Air-ground data link security context definition risk assessment and security requirements version 2
- SESAR1 P09.19-D09 -- SWIM A-G Mainline Aircraft Concept and Airborne System Architecture - version 2
- SESAR1 P09.19-D11 -- SWIM A-G Regional Aircraft Concept and Airborne System Architecture - version 2

SESAR Solution PJ.17-02: SWIM TI Federated Identity Management
- SESAR1 P14.01.03 D38 SWIM Profiles for Step 3 - Iteration 3.1
- SESAR1 14.01.04.D43-001-SWIM-TI Technical Specifications Catalogue 3.0
- SESAR1 P14.01.04 D43-002 SWIM-TI Identity Management Technical Specification 3.0
- SESAR1 P14.02.02 D26 SWIM security spec-design iteration 3.1
- SESAR1 P14.01.04 D43-003 SWIM-TI Run Time Registry Technical Specification 3.0

SESAR Solution PJ.17-03: SWIM TI Green Profile for G/G Civil Military Information Sharing
- SESAR1 P14.01.03 D38 SWIM Profiles for Step 3 - Iteration 3.1
- SESAR1 P14.01.03-D35 SWIM Architectural Definition for Iteration 3.0

SESAR Solution PJ.17-08: SWIM TI Common runtime registry

- SESAR 1 P14.01.03 D38 SWIM Profiles for Step 3 - Iteration 3.1
- SESAR1 P14.01.03-D35 SWIM Architectural Definition for Iteration 3.0
- SESAR 1 14.01.04.D43-001-SWIM-TI Technical Specifications Catalogue 3.0
- SESAR 1 P14.01.04 D43-002 SWIM-TI Identity Management Technical Specification 3.0
- SESAR 1 P14.01.04 D43-003 SWIM-TI Run Time Registry Technical Specification 3.0
- SESAR 1 P14.01.04 D43-004 SWIM-TI Yellow Profile Technical Specification 3.0
- SESAR 1 P14.01.04 D43-005 SWIM-TI Blue Profile Technical Specification 3.0
- SESAR 1 P14.01.04 D43-006 SWIM-TI Purple Profile Technical Specification 3.0
- SESAR 1 P14.02.02 D26 SWIM security spec-design iteration 3.1
- SESAR1 P09.19-D03-001 -- High-Level SWIM A-G Architecture and Functional Requirement Specification
- SESAR1 P09.19-D06 and 09.19-D07 -- SWIM A-G System Architecture, Functional and Technical Requirement Specification
- SESAR1 P09.19-D29 -- SWIM A-G Concept of Operations

Dependencies

Dependencies with Other SESAR Solution Projects

SESAR 2020 solution projects may require operating SWIM TI solutions in their validation activities. For most projects developing solutions that are enabled by G/G SWIM services it is foreseen that the solutions developed in SESAR 1 can be used, in which case there will be no need for involvement of Pj17. Only for projects that depend on solutions being developed in Pj17, is it to be expected that a dependency exists.

It is expected that PJ17 will contribute to document and integrate SWIM TI prototypes in order to support execution of validation exercises defined in other SESAR2020 projects. Also, it will participate in a number of cross projects (and/or programme wide) activities (e.g. contribution to compliance report production and evaluation, definition of governance processes, management of SWIM Evolution…). As it is expected that the “ownership” of such activities will be allocated within the projects that will require such support, it is assumed that PJ17 will have to contribute to deliverables and/or activities of other SESAR 2020 projects (i.e., with working arrangements similar to the ones in SESAR 1, where a project X can foresee a task to contribute to a deliverable owned by a project Y).

The following points detail the expected dependencies that have been identified so far. Further analysis will have to be performed during the initial phases of execution of SESAR 2020 PJ17.

Dependencies with Transversal Projects

- PJ19 - ATM Design and Integration

  It is expected that PJ19 will execute activities related to SWIM Governance and SWIM Management.

Dependencies with other ATM solutions, Enabling Aviation Infrastructure solutions, and with SESAR 1 solutions are provided in the dependencies list that is included in the general technical documentation of the call.

The following list indicates for each Enabling Aviation Infrastructure Project the respective high level need from PJ17. This will have to be confirmed/refined during execution phase:

- PJ14 - CNS
  It is expected that PJ17 will need to provide network requirements to PJ14 as SWIM Infrastructure will make of use of underlying network(s) (different networks will actually be used depending on the context: e.g. PENS, Public Internet, Mobility Network for SWIM A/G). Moreover, different technologies might be needed depending on the "situation" (e.g. Aeromacs on the Airport, VDL2/4 for En-route communication, Satellite based communications etc...), therefore different network requirements will have to be defined depending on the context.

- PJ15 Common Services
  SESAR 1 Project B04.05 Options for High Level Architecture will examine the introduction of Common Services in SESAR. A Common Service is "a service providing a capability in the same form to consumers that might otherwise have been undertaken by them." The rationale for using such services is to reduce the number of times a given service is developed and deployed and to increase the use of more cross-border services to improve cost-effectiveness and the overall performance of ATM, particularly cost effectiveness. During SESAR 2020, the Solution and Enabling Infrastructure Projects will need to co-ordinate with Project 15 to support the identification and definition of new opportunities for Common Services during the development of their solutions and possibly need to support the verification and validation of common services.

- PJ18 4D Trajectory Management
  PJ18 will deal with all aspects and systems related with Trajectory Management. This means that 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 dynamic airspace structures foreseen in the scope of SESAR 2020. The objective is the sharing of the trajectories between the Airspace Users (including the aircraft) 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. This work will require coordination vis-à-vis the development of solutions Pj17-01 and Pj17-07 by this project.

Dependencies with other ATM Solution projects

PJ.17 activities have dependencies with several ATM Solution projects. PJ.17 will develop and verify the SWIM infrastructure prototypes for the solutions it is developing that will be required for operational validation exercises in the context of SESAR solutions projects.

In general, it is expected that when ATM Solution projects will require support from/contribution by PJ.17 (in the form of contribution to deliverables, integration of SWIM prototypes, support to validation exercises), they will foresee necessary "placeholder" tasks (e.g. "SWIM support") in order to allow PJ17 (during execution phase) to explicitly point to those tasks allocating required effort (an estimation of the effort required from PJ17 to support each ATM Solution Project will have to be jointly determined with each ATM Solution project). Pj17 will provide support to these projects when the required support is consistent with the scope of the PJ17. The use of SESAR 1 yellow and blue SWIM TI profile solutions in SESAR 2020 solution projects shall be organised directly in those projects and will not require support from PJ17.

Dependencies summary:

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.17			
Source Project	Source Solution	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing	PJ.17-02 SWIM TI Federated Identity Management	PJ.17-03 SWIM TI Green profile for G/G Civil Military Information Sharing	PJ.17-08 SWIM TI Common runtime registry
PJ.10 Separation Management En-Route and TMA	PJ.10-01b Flight Centric ATC			▨	
PJ.14 CNS	PJ.14-02-04 FCI Network Technologies incl. voice solutions and military interfacing	▨	▨		
SESAR1	#46 Initial SWIM	▨	▨		▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.02	PJ.10		PJ.11	PJ.13	PJ.16	PJ.18	
Source Project	Source Solution	PJ.02-09 Enhanced Runway Condition Awareness	PJ.10-04 Ad Hoc Delegation of Separation to Flight Deck	PJ.10-01b Flight Centric ATC	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations	PJ.13-02-04 GA/R Information management Systems	PJ.16-03 Virtual Centre concept	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)
PJ.17 SWIM Infrastructures	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing	▨				▨			▨
	PJ.17-02 SWIM TI Federated Identity Management						▨	▨	
	PJ.17-03 SWIM TI Green profile for G/G Civil Military Information Sharing			▨					
	PJ.17-07 Purple Profile for Air/Ground Safety-Critical Information Sharing		▨		▨				▨

Dependencies with External Activities

In SESAR 1 a number of Coordination Plans (CPs) with FAA have been set up in order to coordinate and harmonize efforts on-going in SESAR and NextGen programmes on different subjects. In the frame of SESAR 1, a number of CPs was directly or indirectly related to SWIM (CPs 2.x and CPs 3.x). These were addressing a number of subjects ranging from some more directly bound to SWIM concepts as such (e.g. harmonization/compatibility of Data Models, Service Models, overall interoperability framework) to others more related to "ATM scenarios" (e.g. Flight Object exchanges, 4D Trajectory Management etc..).

The needs for coordination on those subjects will likely still be in place in the frame of SESAR 2020 and will have to be supported with adequate resources. PJ17 will therefore ensure the availability of proper resources to:

- Provide expertise on SWIM related subjects in the frame of those CPs
- Provide leadership (or support, depending on the case) for joint production of discussion papers, white papers and/or joint studies on SWIM TI solutions when this will be required
- Participate to review material pertaining SWIM and produced in the context of those CPs.
- As required and approved by SJU, participate to relevant TIM (Technical Interchange Meetings), workshops or other initiatives that might be required outside Europe.

Moreover, relationships with external (i.e., non SESAR 2020) bodies will most likely have to be managed as it is expected that SESAR 1 solutions will be “handed-over” and prepared for deployment by external bodies (i.e. the SESAR Deployment Manager). The evolution towards deployment of the SESAR 1 solutions may require feedback towards SESAR 2020 Pj17.

For what concerns EUROCAE and ICAO coordination please refer to next section below.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

SWIM Technical Infrastructure is the interoperable (runtime) technical infrastructure (Ground/Ground and Air/Ground) over which the data is distributed. Its implementation may, depending on the specific needs, differ from one stakeholder to another, both in terms of scope and way of implementation. It offers SWIM technical services based as much as possible on mainstream IT technologies. It is mostly based on commercial of-the-shelf (COTS) products potentially tailored to ATM, but in some cases specific software needs to be developed. Typically the Pan European Network System (PENS), ATN/IPS networks, wireless IP networks, and the wired Internet provide the underlying basic Ground/Ground and Air/Ground connectivity.

EUROCAE

Since 2007 a number of papers have been presented to the EUROCAE TAC dealing with the subject of SWIM. The last paper dates from May 2012 and established EUROCAE strategic line No 3. Since this date further progress has been made on SWIM by the SESAR 1 programme as well as on the global level. Further the European Commission has started to engage in SWIM deployment through the Pilot Common Project (PCP) initiative. Part of the PCP is Initial SWIM (iSWIM) and this has been a trigger to start SWIM standardisations (EUROCAE, EUROCONTROL …) as well as regulation (EASA).

Through the recently established EUROCAE SWIM Task Force a further update to this strategic line is therefore now being proposed. It contains an overview of the latest SESAR and global SWIM developments as well as explores potential application of SWIM on the EUROCAE activities.

Considering the scope of PJ17 SWIM Infrastructure solutions, potential contributions of PJ17 representatives to EUROCAE working groups could be envisaged on the area of SWIM technologies and profiles (except for any further work on yellow and blue profile, which will not be under the scope of Pj17).

ICAO

As also ICAO is more and more activating initiatives on SWIM by including it in a number of ASBUs (Aviation System Block Upgrades), activating IM (Information Management) Panel etc, it is therefore important to guarantee appropriate participation, support and contribution to the production of material from SESAR side such in order that solutions being defined in SESAR can be, as far as possible, promoted and embraced at ICAO level.

PJ.17 will therefore guarantee active contribution on the production, review, contribution to (e.g.) working papers to be proposed in the context of those ICAO initiatives for the subjects that directly or indirectly relate to SWIM matters.

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps
    - ATM Operational Concept (En Route, TMA, Network management, runway environment…)
    - ATM Operational Experience (En Route, TMA, Network management, runway environment…)
    - ATC users requirements (ground & air)
    - Airspace users, airport operators and airlines operators requirements
    - Pilot/aircraft capabilities and constraints
    - Military specific needs
    - Validation methodologies

- System
    - System engineering, prototyping
    - System testing and verification
    - System design and development
    - System Architecture, SOA
    - ATM tools (Airport systems, CNS, Flight Operations Center, Network…)
    - Aircraft and avionics
    - Certification
    - A/G RF Datalink / data communication
    - Information management
    - Cyber security

- Management and coordination
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture
    - Project management
    - Quality management
    - Configuration Management
    - Requirement Definition

  - Requirement Management
  - Resource Management
  - Cost management
  - Risk Management
  - Communications Management

- Performance and Transversal Areas Assessments
  - Safety, security and environment performance measurement
  - Performance management and analysis, business case analysis

- Pan-European ATM expertise
  - Technical expertise, knowledge and capabilities related to the European network as a whole
  - Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension

Final deliverables for external publication/SESAR Solution Packs

- Technical Specifications (**TS**) for each of the solutions
- Contribution to ADD/Technical Architecture Description (**TAD**)
- Communication material

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

C.18 Enabling Aviation Infrastructure – 4D Trajectory Management (PJ18)

PJ.18	**4D Trajectory[13] Management**

Problem Statement

The SESAR concept is based upon the fundamental element of trajectory sharing. The ultimate goal is a trajectory based ATM system where actors optimise business and mission trajectories through common 4D trajectory information taking into account users priorities and ATC constraints. The objective is the sharing of the trajectories between the ATM actors including Airspace Users through an iterative process to take into account more accurate data once available (e.g. intentions, MET forecast, current traffic, airspace management). This will allow the Airspace User to choose the preferred way of integrating ATM constraints when required.

In order for SESAR to deliver the benefits envisaged, it is essential to understand the many inter-dependent factors, often creating conflicting priorities between an individual Airspace User (Airspace Users) and the wider ATM network.

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 were developed to enable trajectory negotiation among FMP's, airline users and other actors, but trajectories resulting from STAM's or other revisions need to be shared by all ground actors before being executed.
- 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
- Improvement of ATC interoperability during the pre-planning and execution phases of the flight

There is a need to improve integration between these 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 automatically in shared updated trajectory predictions when they concern flight already in execution. In general the RBT revision process is partially validated at the end of step 1.

The notion of RBT in trajectory based operation is also not well defined: beyond the general definition expressed in SESAR 1 documents, there is a need to agree in more details on the elements that will constitute the RBT and understand how these will be used operationally.

While the integration of military users' processes in the network and civil/military coordination is still based on ad hoc mechanisms at the end of SESAR 1, additional studies are needed to consolidate the

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[13] Throughout the description of this project, the term "trajectory" is often used to define the "trajectory prediction" that various actors compute to undertake their business functions.

global integration and also considering addition Airspace Users (e.g. RPAS).

ATM constraints are managed differently by FOC/WOC, NM and ATC's. Information is shared through various documents exchanges (AIC, RAD's, information on LOA's), but each system manages them differently.

The new ATM Solutions proposed in S2020 will need better trajectory predictions and additional data exchanges between systems. The trajectory prediction will need to factor in the level of uncertainty that underlies the data that are used (e.g. aircraft position, weather, aircraft navigation) and will provide to ATC tools data associated to confidence levels.

The ambition of new ATM Solutions is to manage a gate-to-gate trajectory, thus the surface (taxi) trajectory needs to have greater coherency with the airborne part of the trajectory, through better coordination of the stakeholders and systems.

Inconsistencies between various sources for aeronautical (AIM) and meteorological (MET) information will be further removed and so that AU, NM and ATC are enabled to establish a common operating picture with respect to the available infrastructure [AIM] and the meteorological conditions [MET].

SESAR Solution(s) description

Wave 1 activities will close down in 2019 covering Release 6 to Release 8 validation activities. In 2019, V3 activities can be the last ones related to Release 8 (to deliver all material for the Release 8 close out in June 2019) while some V2 activities can also be planned. All of them will have to be scheduled to cope with the closing down profile of Wave 1 to be completed by end of 2019.

This project is part of the thread "Enabling Aviation Infrastructure" and will define solutions that are used in other ATM Solutions. It aims at facilitating the following SESAR Solutions:

- coherent design solutions for managing flight information across the System of Systems architecture, driven by operational requirements elaborated in the various ATM SESAR solution projects; It shall define the trajectory management services fulfilling the requirements expressed by ATM Solution projects using trajectory; and
- will feed them into the design through close work with Content Integration project

More specifically, in terms of flight information management and exchange, this project will cover designing solutions that will support :

- The systematic sharing of appropriate aircraft trajectory information between all actors (Airport, FOC/WOC, 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;
- Submission and maintenance of flight plan information in accordance with the future ICAO FF-ICE provisions.
- Trajectory updates enabling a coherent and timely information available to all stakeholders;
- Assessment of trajectory revisions (including changes due to flow measures) during execution considering the complete trajectory still to be flown, beyond the current sector, and , depending on the time horizon, the wider impact on other flights trajectories, the Network operations , ATC constraints and weather hazards;
- Eligibility rules and criteria allowing actors and processes to initiate different revision processes on the RBT;
- Involving pilot or FOC depending on the operational context, as well as various ATM actors, and

similar clarifications in the military context;

- Merging Short Term ATFCM measures (STAM) and other trajectory revision processes under one uniform process that may involve different sets of users depending on the time horizons, level of (un)certainty on the future trajectory and the types of measures;
- Providing trajectory revision services enabling the implementation (or modification/removal) of flow measures during execution;
- Improving the quality, consistency and exchange, and therefore the usability of the AIM and MET by developing operational procedures and associated system capabilities to support trajectory operations(e.g. MET observations, MET forecasts, MET warnings, products on weather hazards, climate impact optimization and costs, optimization of AIM data distribution through a review of the AIRAC cycle principles);
- Ensuring the constraints that will impact a flight are shared among all actors and especially with the airspace user's so that route can be planned with the most up-to-date knowledge of these constraints.

  Increasing interoperability with other civil and military ATM stakeholders (e.g. Airspace Users, Airports) in order to enable the trajectory management processes that will be defined in SESAR2020 and define the coordination mechanisms with AU to trajectory changes;
- improving the ground trajectory Prediction computation, using airbone data (e.g. EPP, ADD);
- Extending seamlessly to non-ECAC actors and neighbouring ATM actors through the compatibility with global standards (FIXM/FF-ICE)[14].
- Integration of RPAS, high-end GA and rotorcraft trajectory management into ATM processes where appropriate in order to ensure the harmonization of all type of airspace users' operations in terms of safety and efficiency.

This project aims at delivering the following SESAR Solutions:

1. Improved mission trajectories to enable smooth integration of military operations in the ATM network.
2. Integration of trajectory management processes in planning and execution and to improve sharing of trajectory information, and to clarify roles and responsibilities regarding SBT and RBT revision and update processes. Consolidation and extension of the trajectory and flight plan information exchange technical solution to provide the infrastructure enabling seamless operation and trajectory sharing in response to the need of the SESAR Solutions.
3. To make available (i.e. capability development), manage and share AIM and MET information enabling the use and integration of the most up-to-date and suited information in trajectory processes,
4. Improved Trajectory Prediction through data exchange between air and ground and the use of other sources in order to support all advanced operational processes required in S2020.

The development of these Solutions will be coordinated with the various ATM Solution projects where they will be validated. For MET and AIM, this coordination activity will include the

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[14] The management of the 4D Trajectory is strongly depending on the optimal management of the data which compose this trajectory. That means these data need to be especially surveyed to assure their coherency with the official worldwide related "containers" (such as FF-ICE, FIXM, ADS,..): any data which is expected to support the trajectory process must be checked regarding the effective ability of its management

'collection' of all MET and AIM information needs by other Solutions and to use these as the requirements for the required development of consolidated and harmonised MET and AIM information services and underpinning capabilities that will be then used in the final validation activities of the initiating Solutions.

This project has an operational and technical transversal part but it will also develop specific solutions such as:

- Definition of the processes involved in trajectory management with relevant Use Cases;
- Development/improvement prototypes for specific trials, involving ATC's, NM, FOC's, WOC's, airports,
- Performance of Fast Time Simulations in support of the concept definition and requirements regarding performance and feasibility;
- Support to development of future FIXM/FF-ICE/ICAO TBO requirements;
- Consolidate operational requirements towards future FIXM requirements;
- Develop the definition and assessment of the effectiveness and stability of the iterative process of continuous trajectory refinement;
- Ensure global interoperability with non ECAC airlines and service providers, and:
- Collect and consolidate operational and information exchange requirements related to MET and based on these requirements to develop associated coherent and consistent MET information capabilities to support the use and integration of MET information by operational Solutions. This includes the enhancement of the basic-4DWxCube developed in SESAR1 as a technical enabler.

The project shall address the integration of:

- GA/ Rotorcraft: the project will consider GA and Rotorcraft to be AUs, investigating operational requirements specific to these users. Specific technological requirements shall be coordinated with PJ.13.
- Civil RPAS: It is intended that Civil RPAS will integrate safely and transparently in non-segregated airspace, in a multi-aircraft and manned flight environment, guaranteeing the interoperability with the ATM system. Operational considerations specific to RPAS will be identified and technological needs, if any, coordinated with PJ.13.

Cyber security

As the SESAR Target Concept is based on increased automation and system integration based inter alia on the use of COTS components and standard protocols, it is important to consider how potential cyber-threats could affect SESAR developments so that can be effectively mitigated.

In this context Cyber-Security will require adapted operational and technical improvements in the aim when implement, to be ready to detect and analyse possible attacks as early as possible, and respond effectively to avoid their escalation.

It is essential that the development of cyber-security is performed in parallel to the development of the technical enabler, and that cyber-resilience measures are considered in a systematic and joined-up manner.

SESAR Solutions

SESAR Solution PJ.18-01: Mission Trajectories

Solution Description:

Military operations planned for the long term by military Authorities will be shared with network manager. These will be further detailed to the level of individual flights for the medium-short term planning phase.

In a first phase, an improved and harmonised Operational Air Traffic (OAT) flight plan will represent the first description of the Mission Trajectory (MT) and will be integrated into the ATM network systems for processing and distribution.

In a second phase, Mission Trajectories will be integrated in Trajectory Based Operations (TBO) environment throughout all phases of trajectory planning and execution (SMT/RMT). MT will be subject to trajectory management processes and contain 4D targets and ATM constraints. MT profile will be expressed in a 4D dataset and will be distinct from BT when addressing specific mission requirements for ARES, integrated into the trajectory profile description.

Operating environment: Regional, sub-regional, local level.

List of OI steps and enablers:

SOLUTION PJ.18-01 Mission Trajectories	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
AUO-0215 "Sharing iSMT through improved OAT flight plan"	V2	V3			

Enabler Code	Enabler Title
ER APP ATC 143	Upgrade of ATC System to handle Improved OAT Flight Plan
ER APP ATC 82	Enhance FDP to use SBT/SMT, RBT/RMT
MIL-0501	Specifications for the interoperability of military ground systems with SWIM
MIL-0502	Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks
MIL-STD-03	Update of IFPS User Manual to include OAT Specificities in the Flight Plan (Improved OAT flight plan)
NIMS-35	Flight Planning management sub-system enhanced to process improved OAT flight plans
NIMS-45	Initial Flight Planning management enhanced to support initial Mission Trajectory
PRO-014	Procedures harmonised at pan-

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<tr><td></td><td>European level for the management of the Improved OAT FPL (flight plan filing, validation, acceptance and distribution)</td></tr>
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AUO-0216 "Shared MT data in Step 2"

<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>ER APP ATC 10</td><td>Step 2 Mission Trajectory requirements integrated in ATC systems.</td></tr>
<tr><td>ER APP ATC 101</td><td>4D Trajectory Management in Step 2</td></tr>
<tr><td>MIL-0108</td><td>Exchange of specific MT data (ARES description) in standard format</td></tr>
<tr><td>SWIM-APS-12</td><td>Provision and Consumption of Mission Trajectory exchange services (not using FO)</td></tr>
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AOM-0304-A "Mission Trajectories in Step 1"

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<tr><td>AIMS-06</td><td>Ground-Ground AIS provision to ASM</td></tr>
<tr><td>AIMS-19b</td><td>Aeronautical Information system is interfaced to receive and distribute aeronautical information electronically to military systems.</td></tr>
<tr><td>AOC-ATM-14</td><td>Upgrade of WOC system to handle improved OAT flight plans</td></tr>
<tr><td>AOC-ATM-15</td><td>Upgrade of Wing Ops System Technical Architecture to provide Military Mission Trajectory Services</td></tr>
<tr><td>ER APP ATC 143</td><td>Upgrade of ATC System to handle Improved OAT Flight Plan</td></tr>
<tr><td>MIL-0501</td><td>Specifications for the interoperability of military ground systems with SWIM</td></tr>
<tr><td>MIL-0502</td><td>Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks</td></tr>
<tr><td>MIL-STD-03</td><td>Update of IFPS User Manual to include OAT Specificities in the Flight Plan (Improved OAT flight plan)</td></tr>
<tr><td>NIMS-35</td><td>Flight Planning management sub-system enhanced to process improved OAT flight plans</td></tr>
<tr><td>PRO-014</td><td>Procedures harmonised at pan-European level for the management of the Improved OAT FPL (flight plan filing, validation, acceptance and distribution)</td></tr>
<tr><td>PRO-015</td><td>Harmonised ATC Procedures for providing a standardized service to OAT flights at pan-European level</td></tr>
<tr><td>SWIM-APS-01a</td><td>Provision of Aeronautical Information services for Step 1</td></tr>
<tr><td>SWIM-APS-</td><td>Consumption of Aeronautical</td></tr>
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<td>V2</td><td>V3</td><td></td><td></td><td></td>
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<tr><td>02a</td><td>Information services for Step 1</td></tr>
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<tr><td>SWIM-INFR-05a</td><td>General SWIM Services infrastructure Support and Connectivity.</td></tr>
<tr><td>SWIM-NET-01a</td><td>SWIM Network Point of Presence</td></tr>
<tr><td>SWIM-SUPT-01a</td><td>SWIM Supporting Registry Provisions</td></tr>
<tr><td>SWIM-SUPT-03a</td><td>SWIM Supporting Security Provisions</td></tr>
<tr><td>SWIM-SUPT-05a</td><td>SWIM Supporting IP Network Bridging Provisions</td></tr>
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AOM-0304-B "Integrated Management of Mission Trajectories in Step 2"
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<tr><td>A/C-61</td><td>Handling of additional military datalink messages in military aircraft for ATM purpose.</td></tr>
<tr><td>AAMS-16a</td><td>Airspace management functions equipped with tools able to deal with free-routing</td></tr>
<tr><td>AAMS-16b</td><td>Airspace management system equipped with tools able to deal with flexible use of airspace</td></tr>
<tr><td>AAMS-17</td><td>adaptation of all AAMS sub-systems to the common ATM information model</td></tr>
<tr><td>AAMS-18</td><td>Airspace management system enhanced to support the European-wide use of Military Training Area as part of the integrated European airspace planning process</td></tr>
<tr><td>CTE-C06d</td><td>Gateway for CIV/MIL Interoperability</td></tr>
<tr><td>CTE-N01</td><td>GPS L1/L5</td></tr>
<tr><td>CTE-N02</td><td>GALILEO E1/E5</td></tr>
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<tr><td>CTE-N06</td><td>Space Based Augmentation System (SBAS)</td></tr>
<tr><td>CTE-N06a</td><td>EGNOS V2.4.X</td></tr>
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<tr><td>ER APP ATC 10</td><td>Step 2 Mission Trajectory requirements integrated in ATC systems.</td></tr>
<tr><td>PRO-147</td><td>Military Procedures for assessing requirements and developing Mobile Exclusion Areas</td></tr>
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<td>NA</td><td></td><td>V1</td><td>V2</td><td>V3</td>
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__Identification of CNS related needs__

To be determined among:

- *Data link for initial 4D*
- *RNP capability*

__Identification of MET/AIM related needs__

- Needs shall be defined

__For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services__

- Flight data exchange for OAT if not supported by SESAR 1 Solutions.
- SWIM TI Green profile for Ground/Ground civil-military information sharing

SESAR Solution PJ.18-02: Integration of trajectory management processes in planning and execution

__Solution Description:__

This SESAR Solution covers aspects related to the management, negotiation and sharing of the SBT/SMT, the management, update, revision and sharing of the RBT/RMT, and the transition from the SBT/SMT to the RBT/RMT, covering the complete trajectory management lifecycle in planning and execution:

The solution shall consider any trajectory management need expressed by ATM SESAR Solutions #1 -11, consolidate them and provide back to these ATM SESAR Solutions the consolidated functional capability.

The scope of the solution:

This solution has dependencies with all ATM Solution projects involved in the definition / management of the trajectory. It will elaborate coherent design solutions for managing flight information across the System of Systems architecture, driven by operational requirements elaborated in the various SESAR solution projects.

This solution aims at defining processes, eliciting operational requirements, based on the high level architecture for trajectory based operations (TBO), ensuring alignment between the TBO concept and operational validation of SESAR 2020 solution projects.

The solution will also cover SBT/RBT verification process as part of the agreement process providing input to ICAO FF-ICE.

Definition of CDM and fleet prioritisation processes are out of the scope of this solution and more generally out of the scope of the project. However, the TBO concept will need to define the interface between TBO on one hand and CDM and fleet prioritisation processes on the other hand.

Required timing and tolerance of constraints commensurate with the ATM function it serves, needs to be investigated and validated, implying validation of network impact when setting constraints.

From this TBO concept, the performance requirements are to be derived, that drive the solutions for trajectory constraint adherence, trajectory prediction and data com.

Both the Business Trajectory and the Mission Trajectory (solution 1) content will be harmonized with the FF-ICE data set when relevant. This solution will also consider interregional trajectory information exchanges in the planning phase and take into account the gradual deployment of FF-ICE.

The survey of the transition towards FF-ICE today studied at the ICAO level (ATMRPP) has to be done, by studying the role of NM as a gateway that can facilitate the transition of the various actors present in Europe.

The solution will take due account of the needs of all airspace users' types including RPAS, GA and rotorcraft users.

Operating environment: Regional and inter-regional (e.g. interface with outside European region), sub-regional, local level, airport

List of OI steps and enablers:

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<tr><th rowspan="4">SOLUTION PJ.18-02: Integration of trajectory management processes in planning & execution</th><th colspan="5">Maturity</th></tr>
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<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
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.</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>AUO-0218 "SBT including User preferences associated to meteo scenario and DCB scenario"
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<tr><td>AOC-ATM-11</td><td>Integration of constraints and answers</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
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.</td><td>V1</td><td></td><td>V2</td><td></td><td>V3</td></tr>
<tr><td>AUO-0219 "Use of all NOP information (DCB, ASM, weather), to compute optimal trajectory"
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<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-11</td><td>Integration of constraints and answers</td></tr>
<tr><td>ER APP ATC 82</td><td>Enhance FDP to use SBT/SMT, RBT/RMT</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related</td></tr>
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<tr><td>NIMS-21b</td><td>Flight Planning management enhanced to support 4D</td></tr>
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AUO-0220 "Linking of SBTs pertaining to the same aircraft."
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AUO-0221 "Agreement on RBT (associated to tolerances)"
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AUO-0222 "User preferences shared with ATC"
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<tr><td>AGDLS-ATC-AC-11a</td><td>New SPR for PM ADS-C services i4D</td></tr>
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<tr><td>ER APP ATC 82</td><td>Enhance FDP to use SBT/SMT, RBT/RMT</td></tr>
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<tr><td>SWIM-APS-05a</td><td>Provision and Consumption of Flight Object Sharing services for Step 1</td></tr>
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CM-0105-A : “Enhanced ATC processes by the use of new CPDLC messages and related procedures”
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AC-14b	Instructions and clearances (ACL) over ATN B2					
AGDLS-ATC-AC-14c	New SPR for data link exchange of instructions or clearances for ATSA-ITP over ATN B2					
AGDLS-ATC-AC-14d	New SPR for data link exchange of instructions or clearances related to CTA allocation (4DTRAD)					
AGDLS-ATC-AC-14e	New SPR for data link exchange of clearances or instructions for ASAS Spacing					
AGDLS-ATC-AC-14f	New SPR for data link exchange of clearances or instructions for push-back/start-up and taxi (D-Taxi)					
AGDLS-ATC-AC-15a	New IOP for data link exchange of Departure Clearance (DCL) via ATN B2					
AGDLS-ATC-AC-15b	New IOP for datalink exchange of Instructions and clearances (ACL) over ATN B2					
AGDLS-ATC-AC-15c	New IOP for data link exchange of instructions or clearances for ATSA-ITP over ATN B2					
AGDLS-ATC-AC-15d	New IOP for data link exchange of instructions or clearances related to CTA allocation (4DTRAD)					
AGDLS-ATC-AC-15e	New IOP for data link exchange of clearances or instructions for ASAS Spacing					
AGDLS-ATC-AC-15g	New IOP for data link exchange of clearances or instructions for enhanced braking information					
APP ATC 144	TMA Controllers are able to issue instructions to the pilot via CPDLC messages to maintain time-based spacing against other identified aircraft					
CTE-C02b	A/G Datalink over ATN/OSI - Single frequency					
CTE-C02c	A/G Datalink over ATN/OSI - Multi frequency					
CTE-C02e	New IOP for datalink exchange of Instructions and clearances (ACL) over ATN B2					
CTE-C02f	New IOP for data link exchange of instructions or clearances for ATSA-ITP over ATN B2					
ER APP ATC 121	New IOP for data link exchange of instructions or clearances related to CTA allocation (4DTRAD)					
ER APP ATC 149c	New IOP for data link exchange of clearances or instructions for ASAS Spacing					
REG-0100	New IOP for data link exchange of clearances or instructions for enhanced braking information					
AUO-0228 "Agreed iRMT"		V2	V3			
Enabler Code	**Enabler Title**					
AOC-ATM-20	Sharing of trajectory data between					

	AOC/WOC and the ATM world using B2B web services
METEO-06b	Generate and provide MET information relevant for Network related operations, Step 1
NIMS-21b	Flight Planning management enhanced to support 4D

Identification of CNS related needs

- Communication link performance (e.g. Bandwidth, latency) for G-G and A-G.

Identification of MET/AIM related needs

- Tailored, precise, on-time, and shared information on long-term weather hazards along a planned trajectory.
- Tailored, precise, on-time, and shared information on short-term weather hazards along a trajectory

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Several services exist in current ISRM that might be relevant (e.g. Aeronautical Information Services). The list of relevant services will be developed during execution

SESAR Solution PJ.18-04: Management and sharing of data used in trajectory (AIM, METEO)

Solution Description:

1. SESAR 1 Context

SESAR 1 developed a number of enhanced capabilities to enable MET-and AIM-service providers to make available the required MET[15]- and AIM[16]-information of the required quality of service. These enhanced services were mainly based on existing products and focused on making these products more harmonised and consistent amongst States or providers. Another important element was to make the information available in the form of SWIM information services and supporting delivery mechanisms such as the 4D WxCube.

The MET information made available by the various capabilities developed is exchanged through a basic 4D Wx Cube. This 4D Wx Cube is an essential element in this consolidation of all the MET information and is technically capable of providing the right MET information at the various levels of detail and accuracy required for the different phases of 4D trajectory planning and execution. A 4D Wx Cube essentially eliminates the need to exchange huge (not-all-needed) data quantities in proprietary formats as is currently the norm.

In Step 1 it is generally identified and acknowledged that the sharing of MET and AIM information is an

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[15] The term MET information comprises standard meteorological data, observations and forecasts with required quality for intended operations, and also MET products specifically developed for weather hazards as thunderstorm, turbulence, icing, volcanic ash, and environmental and climate impact information.

[16] The term AIM information comprises quality-assured aeronautical information and the associated products such as Aeronautical Information Publication, NOTAM, aeronautical charts, and specific digital datasets (e.g. airspace, routes, terrain and obstacles [ETOD], aerodrome, navaid, airport mapping, procedures, rules and regulations, organisation and services).

important consideration in ensuring that air and ground trajectory prediction processes have access to the same harmonised and consistent information. This assists in the equal reflection of the environmental, technical and operational constraints by these trajectory prediction processes.

2. SESAR 2020 Requirements for MET and AIM information

It is foreseen that the Solutions identified for SESAR2020 will need new or further enhanced MET- and AIM-information services and means of exchange with also different quality of service requirement building on what is already achieved by SESAR 1. Furthermore, some of the MET capabilities developed in SESAR 1, were verified but not fully integrated with the operational SESAR 1 Solutions envisaged thus not properly validated.

The major focus in Step 1 and scope of SESAR 1 is on improving the consistency and quality of MET information to support mainly planning decisions. Similar to the foreseen evolution of ICAO ATM System Block Upgrade Modules for MET, the further evolution of MET information will need to take account of the increased integration of MET information in near-real-time and real-time air transport processes foreseen in SESAR 2020 Solutions.

These new or enhanced requirements anticipated to come from other Solutions will detail the planned activities on specific MET observation and forecast (nowcast) capabilities, the further enablement of the 4D WxCube and aspects related to the exchange of MET information and quality of service aspects. Elements that will be considered:

- Further enhancement of convective weather forecast capabilities (building on SESAR 1 outcomes) to improve usability in a near-real to real-time environment including the required information exchange service (included in METEO-03c, METEO-04c, METEO-05c and METEO-06c);
- Enhancement of low visibility conditions forecasting for all phases of operations including the required information exchange service (included in METEO-03c, METEO-04c);
- Enhancement and consolidation of upper wind and temperature information to support gate-to-gate trajectory planning and execution including the required information exchange service (included in METEO-04c, METEO-05c and METEO-06c);
- Enhancement of turbulence (upper air, i.e. wake- and clear air-turbulence) detection and forecast capabilities to enable ‘turbulence-free planning / re-planning’ including the required information exchange service (included in METEO-05c and METEO-06c);
- Further enhancement of winter weather forecast capabilities to improve its usability in a near-real to real-time Aerodrome and TMA environment (included in METEO-03c, METEO-04c, METEO-05c);
- Enhancement of volcanic ash cloud information (detection, nowcast, forecast) to improve its usability in the en-route environment (included in METEO-05c and METEO-06c);
- Development of MET information services supporting the assessment of the environmental performance of trajectory prediction and execution (included in METEO-04c, METEO-05c and METEO-06c);
- Enhancement of 4D Wx Cube capabilities to meet full 4D trajectory management requirements and quality of service aspects related to the provision of near-real time and real-time integration of MET information; including the availability of fit-for-purpose MET information services and the ability to integrate information on different MET hazards with seamless or fixed forecast horizons whatever required (included in METEO-04c, METEO-05c and METEO-06c);
- Specific MET information considerations for aircraft-based applications (strategic flight optimization, CDM, pilot situational awareness and hazard avoidance) including, e.g. the required ground-air information exchange service, (included in METEO-04c, METEO-05c and METEO-06c), and;
- Enhanced use of existing and foreseen aircraft derived data --specific (e.g. weather radar, LiDAR) and non-specific MET data-- by ATM applications directly or through post-processing by (ATM-) MET application including the required air-ground information exchange service (included in

METEO-04c, METEO-05c and METEO-06c).

For AIM specifically, the new or enhanced requirements anticipated to come from other Solutions will primarily focus on the quality of service aspects of the AIM information and therefore the management of the full data origination chain and the operational integration into the new SESAR 2020 trajectory management concept. A holistic review of the aeronautical data chain will include an analysis of all different aspects of this data chain and an assessment of best practices in other non-ATM domains.

This SESAR Solution will deliver the required elements to make AIM information service provision more flexible and agile to meet the full 4D trajectory management requirements and is likely to come with further proposals on operational, technical and institutional aspects how aeronautical data should be originated, exchanged and used by ground systems, Aircraft Control Domain and Aircraft Information Domain to overcome all the identified quality and efficiency issues..

In general, this SESAR Solution will also develop the required generic AIM- and MET-Information exchange capabilities via both ground-ground SWIM and air-ground SWIM when appropriate to support the various Solution needs including the support to the further enhancement of the required information reference, exchange and service models including standardisation aspects.

3. SESAR 2020 MET- and AIM-Capability development

PJ.18-04 will collect and analyse the MET- and AIM-information requirements from the various other Solutions (including other Solutions defined by PJ.18) and define the required MET- or AIM-capability to meet these requirements as efficiently as possible. It furthermore provides the required MET- and AIM-expertise to the various projects to articulate their AIM- and MET-needs.

Part of the identification and analyses of user needs is an element to identify the demonstrable benefit in providing the required MET- or AIM-information consistent and consolidated with other MET- and AIM-information or that a specific ground or on-board capability should be developed.

PJ18-04 will support the validation of other Solution when and for the MET- or AIM-information used or integrated by providing the required expertise. Validation outcomes will be used to modify the prototypes that provide and exchange the MET- or AIM-information whenever required.

Operating environment: Regional, sub-regional, local level

List of OI steps and enablers:

SOLUTION PJ.18-04 : Management and sharing of data used in trajectory (AIM, METEO)	**Maturity**				
	SESAR 1	**SESAR 2020**			
	Maturity Level at the end of SESAR 1	Wave 1			Wave 2
		R6	R7	R8	
MET-0201 "Enhanced operational near-term decisions through MET information integration"	V1		V2		V3

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<tr><td>METEO-03c</td><td>Provision and monitoring of real-time airport weather information, Step 2</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>METEO-08c</td><td>All-weather remote sensing of high resolution 3D Aerodrome wind field, Step 2</td></tr>
</table>
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</td>
<td></td><td></td><td></td><td></td><td></td>
</tr>
<tr>
<td>
IS-0206 "Digital Integrated Briefing during flight execution phase"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AIMS-23</td><td>Enhanced digital data chain to ensure Aeronautical Information data provision to meet full 4D trajectory management requirements</td></tr>
<tr><td>AIMS-24</td><td>Provide semantic analysis capabilities.</td></tr>
<tr><td>METEO-04c</td><td>Generate and provide MET information relevant for Airport and approach related operations, Step 2</td></tr>
<tr><td>METEO-05c</td><td>Generate and provide MET information relevant for TMA and En-route related operations, including low-level IFR operations, Step 2</td></tr>
<tr><td>METEO-06c</td><td>Generate and provide Meteorological information relevant for Network related operations, Step 2</td></tr>
<tr><td>SWIM-INFR-06b</td><td>AIR/GROUND SWIM Services infrastructure Support and Connectivity.</td></tr>
</table>
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</td>
<td>V1</td><td></td><td></td><td>V2</td><td>V3</td>
</tr>
</table>

Identification of CNS related needs

- G_G and A-G Communication enhanced performance link (e.g. bandwidth, latency...)

Identification of MET/AIM related needs

- Not applicable

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- None

SESAR Solution PJ.18-06: Performance Based Trajectory Prediction

Solution Description:

The notion of Full 4D operation is often associated to the notion of unique RBT. Even though there is one Reference Trajectory (to be determined what it is), we must acknowledge that there are several trajectory predictions held by air and ground actors. Each is computed with its own logic, thus the exchange of data need to be carefully examined as one trajectory does not “overwrite” another one. This solution looks at how the trajectory predictions for ATC, FOC and NM can be improved taking into account all possible data sources (legacy or not):

- Primary, secondary radars information
- ADS-C EPP (4D)
- Last known 4D Extended Flight Plan issued by FOC [17] .
- Additional data sent by the A/C : ADS-B out, Enhanced Surveillance data
- Relevant history data (ex : past ATC instructions …)
- Planned ATC constraints
- MET observation downlinked from the aircraft
- Aircraft status information, for instance in case of engine failure.

This solution has dependencies with all ATM Solution projects involved in the definition / management of the trajectory. It will elaborate coherent design solutions for Trajectory Prediction across the System of Systems architecture, driven by operational requirements elaborated in the various SESAR solution projects.

Information will be given associated “quality parameters” representative of the accuracy and/or confidence for use. As an example, the EPP might be qualified with consideration of the actual airborne Trajectory management modes (Lateral, vertical, speed). As a result, the Trajectory Predictor might be characterized by few “Merit” parameter(s), for instance representative of Accuracy and Integrity.

This solution will take account of the needs of other operational projects regarding the accuracy of the trajectory elements, and the type of information that need to be provided for various levels of performance.

Because the various ATC/NM processes might need such Merit parameter(s) to assess the (e.g.) buffers with which the TP 4D trajectory would be used, a coordination with the relevant projects will be needed to periodically share needs and opportunities.

- This solution builds upon the existing research performed under SESAR1 to support full trajectory based operations
- A high level objective is to improve the accuracy of the trajectory being used by ground actors in various ATM processes. The ADS-C EPP elements that can be used to improve ground trajectory prediction need to be investigated further. The conditions under which these elements are valid to use also need to be understood, to achieve convergence between the air

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[17] The data may include, for example: Aircraft Take-Off Weight, engine variant, actual wind profiles, intent data (next waypoint(s)) and the airline's thrust setting policy

and the ground views.

- The solution will assess the benefits that can be realised in the different ATM applications (e.g. separation provision) using the trajectory prediction improved with ADS-C EPP.
- Once the data that constitute the RBT are well defined, this solution will study how the TMR mechanism is used to update the RBT (even before a revision process needs to be engaged) and define how the ground system should define the parameters depending on the ground TP needs, as well as exploring dynamic and static adjustment of TMR parameters.
- Mission Trajectory specific requirements regarding TP performance shall also be investigated.

The aspect of sharing of METEO data is especially critical in ensuring that air and ground trajectories can be synchronised. Both uplink and downlink information is useful in that regard.

Operating environment: Regional, sub-regional, local level, airport

List of OI steps and enablers:

<table>
<tr><th rowspan="4">SOLUTION PJ.18-06 Performance Based Trajectory Prediction.</th><th colspan="5">Maturity</th></tr>
<tr><th>SESAR 1</th><th colspan="4">SESAR 2020</th></tr>
<tr><td rowspan="2">Maturity Level at the end of SESAR 1</td><td colspan="3">Wave 1</td><td rowspan="2">Wave 2</td></tr>
<tr><td>R6</td><td>R7</td><td>R8</td></tr>
<tr><td>IS-0301 "Provision and use of FOC/WOC data to enhance ATM ground system performance."
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AOC-ATM-20</td><td>Sharing of trajectory data between AOC/WOC and the ATM world using B2B web services</td></tr>
<tr><td>CTE-C06b</td><td>PENS - Phase 2</td></tr>
<tr><td>ER APP ATC 82</td><td>Enhance FDP to use SBT/SMT, RBT/RMT</td></tr>
<tr><td>NIMS-21a</td><td>Initial Flight Planning management enhanced to support 4D for Step 1</td></tr>
</table>
.</td><td>V3</td><td></td><td>V3</td><td></td><td></td></tr>
<tr><td>IS-0302 "Use of Aircraft Derived Data (ADD) to enhance ATM ground system performance."
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-48a</td><td>Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B</td></tr>
<tr><td>AGDLS-ATC-AC-11a</td><td>New SPR for PM ADS-C services i4D</td></tr>
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</td><td>V3-partial</td><td></td><td>V3</td><td></td><td></td></tr>
</table>

<table>
<tr>
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<table>
<tr><td>AGDLS-ATC-AC-11c</td><td>New IOP for PM ADS-C services i4D</td></tr>
<tr><td>ER APP ATC 104</td><td>Adapt Controller Tools to Use Enhanced Trajectory data</td></tr>
<tr><td>REG-0100</td><td>Regulatory Provisions for Datalink Extension (DLS II)</td></tr>
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<td></td><td></td><td></td><td></td><td></td>
</tr>
<tr>
<td>
IS-0303-A "Downlink of onboard 4D trajectory data to enhance ATM ground system performance: initial and time based implementation."
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>A/C-37a</td><td>Downlink of trajectory data according to contract terms</td></tr>
<tr><td>AGDLS-ATC-AC-1</td><td>ICAO PANS-ATM for initial ADS-C based services</td></tr>
<tr><td>AGDLS-ATC-AC-11a</td><td>New SPR for PM ADS-C services i4D</td></tr>
<tr><td>AGDLS-ATC-AC-11c</td><td>New IOP for PM ADS-C services i4D</td></tr>
<tr><td>CTE-C02c</td><td>A/G Datalink over ATN/OSI - Multi frequency</td></tr>
<tr><td>ER APP ATC 100</td><td>4D Trajectory Management in Step 1 - Synchronization of Air and Ground Trajectories</td></tr>
<tr><td>ER APP ATC 119</td><td>Enhance Air/Ground Data Communication for Step 1</td></tr>
<tr><td>ER APP ATC 149a</td><td>Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)</td></tr>
<tr><td>REG-0100</td><td>Regulatory Provisions for Datalink Extension (DLS II)</td></tr>
</table>
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</td>
<td>V3-partial</td><td></td><td>V3</td><td></td><td></td>
</tr>
<tr>
<td>
IS-0305-B "automatic update of EPP from take-off to landing according to TMR (contract terms)"
<table>
<tr><th>Enabler Code</th><th>Enabler Title</th></tr>
<tr><td>AGSWIM-34</td><td>New System AGDLGMS</td></tr>
<tr><td>AGSWIM-38</td><td>SWIM enabled services for AGDLGMS</td></tr>
</table>
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</td>
<td>N/A</td><td>V1</td><td></td><td>V2</td><td>V3</td>
</tr>
</table>

Identification of CNS related needs

The management of the ADS/C information (EPP) will be confronted to the limitation of the capacity of the overall systems to be in position to assure this objective: 2 technical limitations related to ADS-C use may be here quoted:

- ○ Communication link Bandwidth limitation
- ○ Communication Infrastructures availability

<u>Identification of MET/AIM related needs</u>

- Tailored, precise, on-time, and shared information on weather hazards along a planned trajectory
- Cost function for the climate impact of a planned trajectory
- Other needs identified as part of the solution itself.

For SWIM enabled SESAR ATM Solutions, Identification of relevant SWIM services

- Purple Profile for Air/Ground safety critical information sharing

Performance Goals

The project will contribute to:

- Interoperability (air and all ground actors share the same trajectory view)
- Trajectory accuracy (airborne data allow improve ground trajectory used by Ground Automated Tools) and sharing information updates throughout the flight - relates to predictability

The main performance goals where this project is contributing to through the integration with other ATM solution projects are:

- Flexibility: match demand with minimum distortions to the Airspace User needs (Business/Mission Trajectories).
- Flight efficiency (flight is managed closer to its optimal profile)

In addition, PJ.18 will have indirect impact as an enabler to other operational KPAs.

Need for coordination at European/Global level

LOCAL: The SESAR Solution can be locally implemented without any need for G/G or A/G integration regarding this solution, solving a purely local performance need;

NETWORK: The SESAR Solution requires a need for coordination and synchronization e.g. G/G and/or A/G integration in perspective of future deployment at European Network / Global level in order to provide confidence of benefits for targeted reference operating environments (i.e. not just a limited set of locations): Focus on G/G and A/G integration in perspective of future deployment (e.g. cross-OFA focus, addressing variety of systems & equipment & operations).

SOLUTION	LOCAL / NETWORK	JUSTIFICATION/RATIONALE
SOLUTION PJ.18-01 **Mission Trajectories**	N	All solutions in this project are based on trajectory exchanges thus cannot be deployed on a purely local basis
SOLUTION PJ.18-02 **Integration of trajectory management processes in planning and execution**	N	
SOLUTION PJ.18-04 **Management and sharing of data used in trajectory (AIM, METEO)**	N	
SOLUTION PJ.18-06 **Performance Based Trajectory Prediction**	N	

Expected inputs to be considered by the project

The list below contains the deliverables that should be used as a reference to the work on the solutions under the scope of this project. In some cases, the deliverables are subject to changes since activities in SESAR 1 are still on-going.

For all solution **PJ.18-01** to **PJ.18-06**:

- SESAR 1 P07.06.02 D48 Step 1 Technical Specs for OAT prototype
- SESAR 1 P07.06.02 D51 Step 1 Mission trajectory OSED 2015 update
- SESAR 1 P11.01.02 D10 D11.1.2.3mb-WOC - Final WOC Step 1 and Step 2, as available, OSED/SPR/INTEROP
- SESAR 1 P11.01.03 D18 D11.1.3-4mb-WOC - Updated WOC Step 1 and 2 TAD (BMT, AFUA, iOATFPL)
- SESAR 1 P11.01.03 D16 D11.1.3-2mb-WOC - Update Technical Specification Step 1 & Step 2 as available for WOC system (BMT, AFUA, iOATFPL)
- SESAR 1 P07.06.02 D56 Step 1 Business trajectory final OSED
- SESAR 1 P07.06.02 D57 Step 1 Business trajectory final SPR
- SESAR 1 P07.06.02 D42 Step 1 Technical Specs for EFPL V3 prototype
- SESAR 1 P07.06.02 D07 Step 2 V1 OSED - Final
- SESAR 1 P11.01.02 D09 D11.1.2-2cb - Final FOC Step 2 OSED/SPR/INTEROP
- SESAR 1 P11.01.02 D08 D11.1.2-1cb - Final FOC Step 1 OSED/SPR/INTEROP
- SESAR 1 P11.01.03 D10 D11.1.3-2ca-EFPL - EFPL (FOC) Step 1 Technical Specification
- SESAR 1 P04.05 D823 TMF-IOP Technical Note - Final (4.5 Deliverable)
- SESAR 1 P10.02.01 D88 Updated Step 1ATC TM System Requirements - Cycle 3
- SESAR 1 P05.05.02 D04 Final project report on the concept and benefits for improving TP using AOC data
- SESAR 1 P10.02.05 D34,D35,D36 Technical Specs
- SESAR 1 P12.06.03 D07, D12 Technical Specifications
- SESAR 1 P15.04.09.a D05, Report on Ground Sensor Investigations
- SESAR 1 P15.04.09.c, D08, Technical Specification
- SESAR 1 P11.2.1 D19 OSED ATM-MET service provision (and subsequent updates)
- SESAR 1 P11.2.1 D22 DOD ATM-MET services (and subsequent updates)
- SESAR 1 P11.2.1 D31 TAD ATM-MET System (and subsequent updates)

- SESAR 1 P11.2.2 D4 TS ATM-MET Local prototype (and subsequent updates)
- SESAR 1 P11.2.2 D5 TS ATM-MET Sub-regional prototype (and subsequent updates)
- SESAR 1 P11.2.2 D6 TS ATM-MET Network prototype (and subsequent updates)
- SESAR 1 P11.2.2 D23 TS ATM-MET 4D WxCube prototype (and subsequent updates)

Dependencies

Dependencies with Other SESAR Solution Projects

Dependencies with other ATM Solution projects

Input dependencies: the following table contains a non-exhaustive list of the input dependencies identified for this project. SESAR 2020 and SESAR1 Solutions that have been listed as Source Solutions are required as an input for the success of this project and its solutions.

		PJ.18			
Source Project	Source Solution	PJ.18-01 Mission Trajectories	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	PJ.18-06 Performance Based Trajectory Prediction
PJ.01 Enhanced arrivals and departures	PJ.01-01 Extended Arrival Management with overlapping AMAN operations and interaction with DCB		▨		
	PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA		▨		
	PJ.01-03 Dynamic and Enhanced Routes and Airspace				▨
	PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA		▨	▨	
PJ.02 Enhanced Runway Throughput	PJ.02-08 Traffic optimisation on single and multiple runway airports		1		
PJ.04 Total Airport Management	PJ.04-01 Enhanced Collaborative Airport Performance Planning and Monitoring		▨		
	PJ.04-02 Enhanced Collaborative Airport Performance Management		▨		▨
PJ.10 Separation Management En-Route and TMA	PJ.10-01a High Productivity Controller Team Organisation		▨		
	PJ.10-02A Improved Performance in the Provision of Separation		▨		
	PJ.10-02B Advanced Separation Management		▨		
	PJ.10-01b Flight Centric ATC	▨	▨		
PJ.14 CNS	PJ.14-04-03 New use and evolution of Cooperative and Non-Cooperative Surveillance	▨			▨
PJ.15 Common Services	PJ.15-08 Trajectory Prediction Service		▨		
	PJ.15-10 Static Aeronautical Data Service		▨	▨	
	PJ.15-11 Aeronautical Digital Map Service			▨	
PJ.17 SWIM Infrastructures	PJ.17-01 SWIM TI Purple Profile for Air/Ground Advisory Information Sharing			▨	
	PJ.17-02 SWIM TI Federated Identity Management		▨		
	PJ.17-07 Purple Profile for Air/Ground Safety-Critical Information Sharing			▨	
PJ.18 4D Trajectory Management	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)	▨	▨		▨
SESAR1	#28 Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing		▨		
	#34 Digital Integrated Briefing			▨	
	#35 MET Information Exchange			▨	
	#37 Extended Flight Plan	▨	▨		
	#46 Initial SWIM	▨	▨	▨	▨
	#67 AOC Data Increasing Trajectory Prediction Accuracy				▨

Output dependencies: the following table contains a non-exhaustive list of the output dependencies identified for this project. Solutions from this project which have been listed as *Source Solutions* are required for the success of other SESAR 2020 Solutions.

		PJ.02	PJ.03b	PJ.04	PJ.05	PJ.07			PJ.08		PJ.09	PJ.10				PJ.11	PJ.15	PJ.18		
Source Project	**Source Solution**	PJ.02-08 Traffic optimisation on single and multiple runway airports	PJ.03b-01 Enhanced Airport Safety Nets for Controllers	PJ.04-02 Enhanced Collaborative Airport Performance Management	PJ.05-03 Remotely Provided Air Traffic Services from a Remote Tower Centre with a flexible allocation of aerodromes to Remote Tower Modules	PJ.07-01 AU Processes for Trajectory Definition	PJ.07-02 AU Fleet Prioritization and Preferences	PJ.07-04 AU Trajectory Execution from FOC perspective	PJ.08-01 Management of Dynamic Airspace configurations	PJ.08-02 Dynamic Mobile Areas (DMA) of types 3	PJ.09-02 Integrated Local DCB Processes	PJ.10-01a High Productivity Controller Team Organisation	PJ.10-02A Improved Performance in the Provision of Separation	PJ.10-02B Advanced Separation Management	PJ.10-01b Flight Centric ATC	PJ.11-G1 Enhanced Ground-based Safety Nets adapted to future operations	PJ.15-08 Trajectory Prediction Service	PJ.18-01 Mission Trajectories	PJ.18-02 Integration of trajectory management processes in planning and execution	PJ.18-06 Performance Based Trajectory Prediction
PJ.18 4D Trajectory Management	PJ.18-01 Mission Trajectories						▨	▨	▨	▨	▨				▨	▨				
	PJ.18-02 Integration of trajectory management processes in planning and execution	▨		▨		▨	▨	▨	▨		▨	▨	▨	▨	▨	▨				
	PJ.18-04 Management and sharing of data used in trajectory (AIM, METEO)		▨	▨	▨	▨	▨	▨	▨		▨					▨		▨	▨	▨
	PJ.18-06 Performance Based Trajectory Prediction																▨			

The project will closely collaborate with PJ14 CNS Project in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solution plan & execute V&V activities with due consideration for future CNS Performance capabilities;
- Ensure the use of CNS prototypes in support of the ATM solutions validation.

Dependencies with External Activities

ICAO:

- Aviation System Block Upgrades (ASBU)
- Block 1 (2018-2023), Block 2 (2023 - 2028), Block 3 (2028-2033)
- Modules Bx-FICE on Block 1, 2 and 3
- Modules Bx-TBO on Block 1 and 3
- Module B#-AMET (Block 1 and Block 3) for MET
- Module B#-DATM (Block 1) for AIM

It must be noticed that according to the current Global Air Navigation Plan it is expected to switch from B1-TBO ("*Improve the synchronisation of traffic flows at en-route merging points and to optimize the approach sequence through the use of 4DTRAD capability and airport applications, e.g. DTAXIv*" directly to B3-TBO ("*Trajectory-based operations deploys an accurate four-dimensional trajectory that is shared among all of the aviation system users at the cores of the system*". Therefore the lack of one B2-TBO description must certainly be highlighted in the frame of the preparation of the next GANP revision.

The link between Bx-FICE and Bx-TBO must be surveyed as an important one regarding the data to be managed to support the TBO view and thus as written in the description of B2-FICE: *"FF-ICE supporting trajectory-based operations through exchange and distribution of information…. "*.

Standards / Regulations

On-going & Future applicable standardisation / regulatory activities

PJ18 will feed validation results that can be used in future updates of FF-ICE concept.

PJ18 will provide validation feedback to be used when updating the ICAO TBO concept.

PJ18 will also provide input to standardize FIXM through the developments of SESAR extensions to be used in FIXM.

PJ18 will also provide input to WG-59 to provide maintenance of ED133 Rev A and provide inputs to the future revisions of ED133.

- SC227 (previous SC227/WG85) – MASPS, MOPS for avionics.
- SC214/WG78 – datalinks for 4D data, IM, D-RNP, etc.
- SC206 - AIS/MET services.
- ED133 WG 59).
- FIXM
- AIXM
- WXXM
- iWXXM

Early engagement with the regulator during the solution development and validation process can significantly de-risk subsequent issues related to regulatory needs, approvals, safety assessments etc. for an ATM solution. With this in mind EASA and/or NSA involvement through the partners shall be envisaged at the level of advising on the suitability of the safety assessments as well as risk and hazard identification and mitigation approaches required for the solution. The potential need for future rulemaking to support the eventual implementation of the solution shall be identified along with the need for standards development in support of any required means of compliance. The work of the project shall then be appropriately focused on delivering the material that could form the basis for this standardisation and regulatory development.

Contribution to the development of standards is expected to form an integral part of the project for those solutions where a standardisation need has been identified or can be anticipated. Projects shall propose where standardisation is expected and target the necessary activity and specific deliverables that will contribute to achieving a coherent link between the SESAR projects and the related standardisation developments.

Required Expertise

- Operations:
    - SESAR ConOps,
    - ATM Operational Concept (En Route, TMA, Airport, Network management, runway environment…),
    - ATM Operational Experience (En Route, TMA, Airport, Network management, runway environment…),
    - ATC users requirements (ground & air),
    - Airspace users, airport operators and airlines operators requirements,
    - Pilot/aircraft capabilities and constraints,
    - Military specific needs,
    - Validation methodologies,
    - Meteorology
    - AIM
- System:
    - System engineering, prototyping,
    - System development,
    - System Architecture, SOA,
    - ATM tools (Airport systems, CNS, Flight Operations Centre, Network…),
    - Aircraft and avionics;
    - Datalink / data communication,
    - Ergonomics, Human-machine Interface (HMI)
    - Information management,
    - Verification methodologies,
- Management and coordination:
    - Understanding of SESAR Programme objectives and work breakdown structure, ATM Master Plan and Target Concept & Architecture,
    - Project management,
    - Quality management.
- Performance and Transversal Areas Assessments
    - Safety, security and environment performance measurement,
    - Performance management and analysis, business case analysis,
- Pan-European ATM expertise:
    - Technical expertise, knowledge and capabilities related to the European network as a whole,
      Development of pan-European Air Traffic management solutions, encompassing Civil/Military dimension.

Final deliverables for external publication/SESAR Solution Packs

- Architecture Artefacts
- Technical Specs
- Verification Reports
- Validation Reports (for related integrated/large scale validations)
- Communication Plans and results

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 BAFO set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Efforts

In addition to the resources required for the execution of the Projects activities (e.g. validation, coordination with Transversal Areas projects), Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant international coordination activities (e.g. FAA Coordination Plans) must also be identified and planned.

Appendix D SESAR2020 Project Descriptions - Wave 1 of Very Large Scale Demonstrations

D.1 High Performing Airport Operations – Integrated Airport Operations (PJ28)

Title: PJ28 - Integrated Airport Operations

Demonstration overview

Airport Integration and Throughput facilitates the provision of approach and aerodrome control services by improving runway safety and throughput, enhancing taxi integration and safety and reducing hazardous situations on the runway.

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge “industrial research” and “deployment” related to the PCP ATM Functionality 2 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of connected SESAR high-technology demonstration platforms in relation to the “High Performing Airport Operations” key feature of the SESAR 2020 programme. This VLD shall aim at a minimum at a demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of additional end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will run in parallel.

This Wave 1 VLD is focused on demonstrating at least 3 of the following functionalities as defined in the PCP regulation for each of the targeted platforms:

- Departure Management Synchronised with Pre-departure sequencing:
    a. Departure management synchronised with pre-departure sequencing is a means to improve departure flows at one or more airports by calculating the Target Take Off Time (TTOT) and Target Start Approval Time (TSAT) for each flight, taking multiple constraints and preferences into account. Pre-departure management consists of metering the departure flow to a runway by managing Off-block-Times (via Start-up-Times) which take account of the available runway capacity.
    b. In combination with Airport Collaborative Decision Making (A-CDM), Pre- departure management reduces taxi times, increases Air Traffic Flow Management-Slot (ATFM-Slot) adherence and predictability of departure times. Departure management aims at maximising traffic flow on the runway by setting up a sequence with minimum optimised separations.
    c. Operational stakeholders involved in A-CDM shall jointly establish pre-departure sequences, taking into account agreed principles to be applied for specific reasons (such as runway holding time, slot adherence, departure routes, airspace user preferences, night curfew, evacuation of stand/gate for arriving aircraft, adverse conditions including de-icing, actual taxi/runway capacity, current constraints, etc.).
- Departure Management integrating Surface Management Constraints:
    a. Departure management integrating surface management constraints is an ATM tool that determines optimal surface movement plans (such as taxi route plans) involving

the calculation and sequencing of movement events and optimizing resource usage (e.g. de-icing facilities). The departure sequence at the runway shall be optimised according to the real traffic situation reflecting any change off-gate or during taxi to the runway.

  b. Advanced Surface Movement Guidance and Control Systems (A-SMGCS) shall provide optimised taxi-time and improve predictability of take-off times by monitoring of real surface traffic and by considering updated taxi times in departure management.

- Time-Based Separation for Final Approach:
  a. Time-Based Separation (TBS) consists in the separation of aircraft in sequence on the approach to a runway using time intervals instead of distances. It may be applied during final approach by allowing equivalent distance information to be displayed to the controller taking account of prevailing wind conditions. Radar separation minima and Wake Turbulence Separation parameters shall be integrated in a TBS support tool providing guidance to the air traffic controller to enable time-based spacing of aircraft during final approach that considers the effect of the headwind.
- Automated Assistance to Controller for Surface Movement Planning and Routing:
  a. The routing and planning functions of A-SMGCS shall provide the automatic generation of taxi routes, with the corresponding estimated taxi time and management of potential conflicts.
  b. Taxi routes may be manually modified by the air traffic controller before being assigned to aircraft and vehicles. These routes shall be available in the flight data processing system.
- Airport Safety Nets:
  a. Airport safety nets consist of the detection and alerting of conflicting ATC clearances to aircraft and deviation of vehicles and aircraft from their instructions, procedures or routing which may potentially put the vehicles and aircraft at risk of a collision. The scope of this sub-functionality includes the Runway and Airfield Surface Movement area.
  b. ATC support tools at the aerodrome shall provide the detection of Conflicting ATC Clearances and shall be performed by the ATC system based on the knowledge of data including the clearances given to aircraft and vehicles by the air traffic controller, the assigned runway and holding point. The air traffic controller shall input all clearances given to aircraft or vehicles into the ATC system using a digital system, such as the EFS.
  c. Different types of conflicting clearances shall be identified (for example Line-Up vs. Take-Off). Some may only be based on the air traffic controller input; others may in addition use other data such as A-SMGCS surveillance data.
  d. Airport Safety Nets tools shall alert air traffic controllers when aircraft and vehicles deviate from ATC instructions, procedures or route. The air traffic controller instructions available electronically (through a digital system, such as EFS) shall be integrated with other data such as flight plan, surveillance, routing, published rules and procedures. The integration of this data shall allow the system to monitor the information and when inconsistencies are detected, an alert shall be provided to the air traffic controller (for example no push-back approval).

For this VLD particular attention shall be paid independently of the location of the targeted platform to the integration of the data of the Airport (AOP) and Network Operation Plans (NOP).

This demonstration will assess the benefit of Integrated Airport Operations to improve ATM Network performance; it will serve as Proof of Concept for AF#2 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- At least two airport platforms at the level of pre-operational or operational status to support the Proof of Concept.
- The Network Manager platform at the level of pre-operational or operational status to support the Proof of Concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation these are:

- Departure Management Synchronised with Pre-departure sequencing:
  - Departure Management (DMAN) and A-CDM systems shall be integrated and shall support optimised pre- departure sequencing with information management systems for airspace users (Target Off Block Time (TOBT) feeding) and airport (contextual data feeding)
  - DMAN systems shall elaborate a collaborative sequence and provide both TSAT and TTOT. TSAT and TTOT shall take into account variable taxi times and shall be updated according to the actual aircraft take-off; DMAN systems shall provide the air traffic controller with the list of TSAT and TTOT for the aircraft metering
- Departure Management integrating Surface Management Constraints:
  - DMAN systems shall take account of variable and updated taxi times to calculate the TTOT and TSAT. Interfaces between DMAN and A-SMGCS routing shall be developed
  - DMAN integrating A-SMGCS constraints using a digital system, such as Electronic Flight Strips (EFSs), with an advanced A-SMGCS routing function shall be integrated into flight data processing systems for departure sequencing and routing computation
  - An A-SMGCS routing function shall be deployed
- Time-Based Separation for Final Approach:
  - The flight data processing and AMAN systems shall be compatible with the TBS support tool and able to switch between time and distance based wake turbulence radar separation rules
  - The controller working position shall integrate the TBS support tool with safety nets to support the air traffic controller, in order to calculate TBS distance respecting minimum radar separation using actual glide-slope wind conditions
  - Local meteorological (MET) information providing actual glide slope wind conditions shall be provided to the TBS support tool
  - The TBS support tool shall provide automatic monitoring and alerting on non-conformant final approach airspeed behaviour, automatic monitoring and alerting of separation infringement and automatic monitoring and alerting for the wrong aircraft being turned on to a separation indicator
  - The TBS support tool and associated controller working position shall calculate Indicator distance and display it on controller displays

  - Safety nets capturing automatic monitoring and alerting of separation infringement shall support TBS operations
- Automated Assistance to Controller for Surface Movement Planning and Routing:
  - The A-SMGCS routing and planning function shall calculate the most operationally relevant route as free as possible of conflicts which permits the aircraft to go from stand to runway, from runway to stand or any other surface movement.
  - The controller working position shall allow the air traffic controller to manage surface route trajectories.
  - The flight data processing system shall be able to receive planned and cleared routes assigned to aircraft and vehicles and manage the status of the route for all concerned aircraft and vehicles.
- Airport Safety Nets
  - Airport Safety Nets shall integrate A-SMGCS surveillance data and controller runway related clearances; Airport Conformance Monitoring shall integrate A-SMGCS Surface Movement Routing, surveillance data and controller routing clearances
  - A-SMGCS shall include the advanced routing and planning function to enable conformance monitoring alerts
  - A-SMGCS shall include a function to generate and distribute the appropriate alerts. These alerts shall be implemented as an additional layer on top of the existing A-SMGCS Level 2 alerts and not as a replacement for them
  - The controller working position shall host warnings and alerts with an appropriate human-machine interface including support for cancelling an alert
  - Digital systems, such as EFSs, shall integrate the instructions given by the air traffic controller with other data such as flight plan, surveillance, routing, published rules and procedures.

Contextual Information

Integration of AMAN and DMAN with the A-CDM processes

Integration of Arrival Management/Departure Management (AMAN/DMAN) is especially relevant between airports with interferences and airport pairs Origin-Destination. The effectiveness of AMAN-DMAN is improved by interfacing the Network Operation Plan (NOP) and the AOP. Issued Target Time of Arrival (TTA) to inbound flights are visible in the destination AMAN facilitating airport planning of ground operations and pre-departures sequence. A-CDM operations can start Target Off Block Time (TOBT) and Target Start-up Approval Time (TSAT) process with enhanced time margins and interacting with the arrival sequence. DMAN sequence can then deliver performance benefits from a constantly updated arrival sequence well before the beginning of the outbound operation.

Airport Surface Management

The importance of moving aircraft on the airport surface from stand to runway and vice versa in a safe, controlled and organised manner is paramount for airports and even more when capacity restrictions depending on weather, or other circumstances affect operations. In step 1, optimum management of surface traffic flow not only increases efficiency, predictability and capacity during the ground movement phase but also has a positive impact on the environment. The planning of surface routes may consider constraints imposed by the need to minimise the environmental impact especially surface holding or the need to avoid braking or changes in engine thrust levels as the aircraft moves from the runway to the stand or vice versa.

Surface Planning and Routing

During the Short Term planning phases of the flight, the system provides Controller with a calculated route based on criteria like planning (delay reduction) and ground rules, while minimizing potential conflicting situations with other mobile units. Once that trajectory is calculated and during execution, the system informs the ground Controller of any deviation from route or previous planned surface trajectory it might detect, using conformance monitoring function.

Surface management Integrated with Arrival & Departure Management

The taxiing process is considered as an integral part of the process chain from arrival to departure and AMAN/DMAN is integrated with A-CDM processes between airport operator, Airspace Users and Air Traffic Service Providers at the same airport, thus improving predictability of the airport processes and ground handling activities. In addition, operational integration of DMAN functions into the surface management is done by taking into account the collaborative pre-departure sequence, off-block information, actual traffic on the surface and constraints related to ATFM slot, runway, taxiway and environment, providing more stable and predictable departure sequence thanks to a better awareness of traffic situation on the ground. The AMAN metering arrival function is integrated into the airport operational data that feeds the surface management system. Therefore, the operational integration of AMAN/DMAN with surface management operations addresses the issue of dependency between arrivals and departures on a runway and especially in mixed mode operations in order to minimise or better manage delays.

The combination of this integrated approach of managing and synchronising surface operations with arrival and departures is aimed also to take into account the noise mitigation needs around the airport, by integrating stand management and arrival routes that best match the optimum taxi route to stand. In addition, this directly affects the aircraft fuel use and emissions at and around airports by electing the best balanced options between airport throughput and environmentally sustainable operations.

Time based operations

The application of time based wake turbulence radar separation rules on final approach (TBS-Time Based Separation) aims at stabilising the overall time spacing between arrival aircraft in particular in strong headwind conditions. The Final Approach Controller and the Tower Runway Controller are provided with the necessary TBS management tools. They enable an accurate delivery on final approach consistent with TBS rules. Minimum radar separation and runway related spacing constraints must still be respected when applying the TBS rules.

The objective is to enable a tactical increase in the achieved arrival and departure capacity in favourable weather conditions. This helps dealing more efficiently with the fluctuations in arrival and departure demand with a positive effect on runway queuing related delays.

Airport Safety Nets

Surface movement capacity is to be increased without increasing the risk of runway incursions and taxing and apron incidents and/or accidents. To achieve this objective, a range of actions need to be taken, to maintain or even improve safety levels. Better situational awareness both for Controller and Flight Crew including conflict detection and alerting systems enhances airport surface safety but creates also room for increasing surface movement capacity.

Safety Nets

The system begins to detect conflicts and infringements of some crucial ATC instructions or rules involving aircraft and/or vehicles on runways, and provides Controller with appropriate alerts. Whereas conflict detection identifies a possible collision between aircraft and/or vehicles, the system now also focuses on dangerous situations arising whenever one or more mobile unit infringes ATC instructions or rules. This improvement also addresses aircraft incursions into an area where the presence of an aircraft (or vehicle) is temporarily restricted or forbidden.

Appropriate alerts are provided to Controllers and Flight Crew. Potential resolution advisories are provided to Controllers/Pilots depending on the complexity of resolution possibilities.

Essential prerequisites

The following prerequisites are required:

- Digital systems, such as EFS, A-CDM and initial DMAN for Departure Management Synchronised with Pre- departure sequencing
- Digital systems, such as EFS, initial DMAN and A-SMGCS for Departure Management integrating Surface Management Constraints
- Digital systems, such as EFS for TBS
- Digital systems, such as EFS and A-SMGCS for Automated Assistance to Controller for Surface Movement Planning and Routing
- Digital systems, such as EFS and A-SMGCS surveillance for Airport Safety Nets.

Deliverables

- Demonstration Plan
- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Automated Assistance to Controller for Surface Movement Planning and Routing
- Airport Safety Nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances
- Pre-Departure Sequencing supported by Route Planning
- Departure Management integrating Surface Management constraints
- Time Based Separation
- Airport Operations Plan and AOP-NOP Seamless Integration

Potential cooperation opportunities with other Demonstration projects

- Network Collaborative Management

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are "certified" against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this "early" SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.
- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

EUROCAE WG-41 is working on the development of an update of the ASMGCS standards and addition standards developments on airport safety nets planned for publication in 2017. The project should therefore plan the appropriate participation and input of results into the working group.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.2 Optimised ATM Network Services – Network Collaborative Management (PJ24)

Title: PJ24 - Network Collaborative Management

Demonstration overview

Network Collaborative Management improves the European ATM network performance, notably capacity and flight efficiency through exchange, modification and management of trajectory information. Flow Management shall move to a Cooperative Traffic Management environment, optimising the delivery of traffic into sectors and airports and the need for Air Traffic Flow and Capacity Management (ATFCM) measures

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge “industrial research” and “deployment” related to the PCP ATM Functionality 4 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of connected SESAR high-technology demonstration platforms in relation to the “Optimised ATM Network Management” key feature of the SESAR 2020 programme. This VLD shall aim at a minimum at a demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of additional end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will run in parallel.

This VLD shall address measures coordinated in the pre-departure phase of flight(s), as well as measures coordinated in the execution phase of flight(s). The coordination process is seen as continuous function that may deal with various phases of flights simultaneously. Measures and coordination processes may be depending on the specific phase of the flight(s).

The demonstration platform(s) to be established shall 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 (including the link to airport planning processes) to identify and manage hotspots.

Particular attention shall be paid to enhanced DCB procedures supported by automated tools:

- Hotspot detection through the use of a tool set (including automated identification and warning support where applicable) 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.

Local En-Route DCB tools shall use SWIM Services to interconnect the local tools and NM system (including the link to airport systems). This demonstration will focus on how the local unit uses the available DCB toolbox to identify the adequate measure to be taken to address a hotspot. The tool box shall include the following measure types:

- Time modification (only pre-departure): measures modifying the timing of the flight trajectory i.e. every measure that leads to the calculation of a TTO/TTA and CTOT. 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 Network 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).

This demonstration will assess the benefit of Collaborative Network Management to improve ATM Network performance; it will serve as Proof of Concept for AF#4 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- The Network Manager platform at the level of pre-operational or operational status to support the Proof of Concept.
- At least 3 ATS platforms at the level of pre-operational or operational status to support the Proof of Concept.
- At least 2 airport platforms at the level of pre-operational or operational status to support the Proof of Concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation these are:

- ATFCM planning shall be managed at network level by the Network Manager and at local level by the flow management position to support hot-spot detection, execution of STAM, network assessment and continuous monitoring of network activity; ATFCM planning at network and local level shall be coordinated with each other.
- Operational stakeholders shall be granted access to the data they need through queries within the NOP.
- Operational stakeholder ground systems shall be adapted to interface with network management systems. AOP systems shall interface with the NOP systems to implement a

Collaborative NOP.

- Interface between operational stakeholder systems and network management systems shall be implemented using System-Wide Information Management services once available.
- Network Manager's systems shall support target time sharing. Systems shall be able to adjust Calculated Take- off Times (CTOTs) based on refined and agreed TTAs at the destination airport; TTAs shall be integrated into the AOP for subsequent refinement of the NOP.
- Flight data processing systems may need to be adapted in order to process downlinked trajectory data (ADS-C EPP).
- Network Manager systems shall deal with flexible airspace structures, route configuration allowing the management of traffic loads and complexity in a collaborative manner at flow management position and network level.
- The flight data processing systems shall interface with the NOP.
- Flight planning systems shall support EFPL and Network Manager systems shall be able to process EFPL.
- Information provided through Route Availability Document (RAD) and Profile Tuning Restriction (PTR) shall be harmonised through the Collaborative Decision Making (CDM) process of the European Route Network Design and ATFM functions of the Network Manager such that Flight Planning System Providers shall be able to generate a flight plan routing that will be accepted with the most efficient trajectory.
- ASM/ATFCM tools shall be able to manage different airspace availability and sector capacity, including A-FUA, Route Availability Document (RAD) adaptation and STAM.

Contextual Information

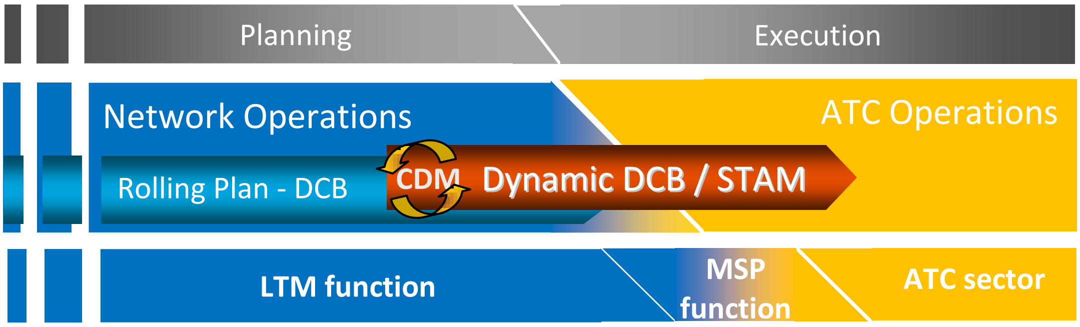
Dynamic DCB / Short-Term ATFCM Measures

They constitute a step forward to close the gap between ATFCM and ATC. The objective is to anticipate and manage traffic peaks and complexity, to smooth ATC workload through the application of fine-tuned measures e.g. Short Term ATFCM Measures (STAM) close to the real time operations, providing significant improvements in overall Network capacity and efficiency, with minimum curtailing for the Airspace Users.

In order to do so, workload calculation and monitoring is improved and procedures to support the process are developed that require dynamic coordination between Local Traffic Managers (LTM),Multi Sector Planner (MSP), Airspace Users and the Network Manager (through CDM).

STAM consist of measures like minor ground delays, appropriate flight level capping, exiguous rerouting etc., applied on a limited number of flights after coordination, with direct effect on workload/complexity resolution and/or delay reduction.

This process complements current global hour-based capacity management with much more focused minute-based activity at sector level. It will connect ATFCM planning activities with tactical ATFCM interventions up to the ATC working horizon: in that timescale, LTM and MSP actors will work closely to identify, agree and implement dynamic DCB initiatives as operationally appropriate.



Complexity management

It aims at simplifying the ATM situation so that Separation Provision can be efficiently provided by human intervention. Complexity management begins with the detection of zones/volumes of high complexity to enable the following processes to ensure the safe and orderly management of air traffic:

- safe transition from free route operations to route based operations,
- definition of the optimum sector organisation to provide the most efficient service, using, when possible Dynamic sector configurations and multi sector planning,
- modification of individual trajectories to reduce complexity when needed,
- implementation of measures on traffic flows in order to react to specific ATC constraints (e.g. availability of airspace -due to weather, special use of airspace-, availability of ATC sector capacity, etc.).

Complexity measurement is an essential input for workload assessment in DCB and dynamic DCB activities.

Complexity and Workload Assessment

Complexity assessment relevant for network management is an activity based upon likely interactions of traffic flows, traffic pattern and airspace demand on traffic load and Controller workload. Complexity assessment is sensitive to specific geographical parameters and consequently, relies on local knowledge and experience. Local complexity assessments form an essential part of the network view.

Factors that affect the complexity assessment include: Quality and granularity of trajectory data, current operational conformance, airspace reservation/restriction activation conformance, (Is the network performing in an expected manner?) and probability of non-nominal weather occurrence, integration of unscheduled operations (GA/R, Business Aviation).

Complexity and Workload assessment is an on-going process carried out by the Network Manager, Flow Manager and Local Traffic Manager. At a basic level, it is achieved by monitoring the deviation of the current traffic picture compared to the planned traffic demand, and continuously measuring traffic load and complexities.

Complexity and workload assessment provides traffic updates to the NOP, and is input to the DCB process.

Complexity Management and DCB Operations

To ensure an efficient complexity management, all critical factors (e.g. timeframe, geographical dimensions, etc.) that influence the complexity prediction and the measures to react, have to be taken into consideration. Complexity is a constantly evolving factor, and the level of accuracy of its prediction varies during all the planning phases, even until the very day of operations. This generates, in turn, changing requirements for the supporting tools and therefore, for the actions taken by the actors in the process of complexity management. (Examples of key elements affecting traffic complexity are; airspace characteristics and environmental aspects; traffic demand; all other factors relevant to specific situations…all elements liable to change rapidly and at the last minute).

Complexity Management begins when traffic complexity is assessed and managed as part of the Demand & Capacity Balancing function, a precursor to the Separation Management Process. Forecasted complexity, coupled with demand enables DCB to take timely action to adjust capacity, airspace configuration or demand profiles through various means, in collaboration with ATC and Airspace Users. Complexity management therefore supports, among other things:

- the research of appropriate strategies to solve imbalances between demand and capacity (advanced DCB measures),
- the research of appropriate airspace configuration: transition from free route to route based operations,
- the determination of the optimum sector organisation, or airspace reservation/restriction partitions and activation timeframe,
- the modification of trajectories by route, level or timing.

Dedicated monitoring tools are shared with ATC to ensure full consistency between complexity assessment activities, Network Management functions and ATC.

Essential prerequisites

There are no prerequisites for this VLD. An existing STAM phase 1 implementation would facilitate the demonstration.

Deliverables

- Demonstration Plan
- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- CTOT and TTA
- Advanced Short ATFCM Measures (STAM)
- Automated Support for Dynamic Sectorisation
- Collaborative NOP for Step 1
- Automated support for Traffic Complexity Detection and Resolution
- Extended Flight Plan
- Initial SWIM

Potential cooperation opportunities with other Demonstration projects

- Flexible Airspace Management and Free Route
- Arrival Management extended to en-route Airspace
- Flight Information Exchange
- Integrated Airport Operations
- Initial Trajectory Information Sharing

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are “certified” against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this “early” SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.
- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the

applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.3 Advanced Air Traffic Services – Flexible Airspace Management & Free Route (PJ23)

Title: PJ23 - Flexible Airspace Management and Free Route

Demonstration overview

Combined operation of Flexible Airspace Management and Free Route (FRA) enable airspace users to fly as closely as possible to their preferred trajectory without being constrained by fixed airspace structures or fixed route networks. It further allows operations that require segregation, for example military training, to take place safely and flexibly, and with minimum impact on other airspace users

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge “industrial research” and “deployment” related to the PCP ATM Functionality 3 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of connected SESAR high-technology demonstration platforms in relation to the “Advanced Air Traffic Services” key feature of the SESAR 2020 programme. This VLD shall aim at a minimum at a demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of additional end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will run in parallel.

This VLD will demonstrate multi FAB Free Route within low to high complexity environments including interfaces with adjoining airspace. This VLD shall focus in particular at the following:

- Direct Routing operations in low to high complexity context with special focus on interface with Free Route Airspace
- Free Routing operations in low to medium complexity context
- Switch between Free Routing Operations and Direct Routing Operations
- Vertical transition from Direct Routing Airspace/Free Routing Airspace to adjoining airspace. To that end special attention should be paid to extended arrival sequencing as the implementation of advanced tools possibly could increase complexity.

The demonstration shall include military operations adjusted to airspace scenario (examples can be found in FABs with already implemented Free Route concepts).

Elements of flexible airspace management should be included, especially:

- AMC coordination taking into stakeholders’ needs for effective mission and flight planning respectively;
- Solutions for in-flight FPL re-filing;
- ATFCM data sharing and mitigation actions for short- and medium-term flow changes due to unplanned airspace activation; and ATC capacity monitoring.
- Controller tools (system supported coordination, monitoring tools, conflict detection tools etc.), safety nets and procedures ensuring efficient rerouting and information sharing with affected ATSUs
- ARES compatible with Free Routing operations to fulfil FUA requirements in accordance with Variable Profile Area (VPA) principles

- FUA principles in both strategic and tactical level to be applied in order to facilitate dynamic management of airspace;
- Enhanced data exchange mechanisms between NM (ADR) and AMC's (ASM Tools) in order to share current and planned airspace configuration.
- NM FRA flight plan management according to projected airspace availability;
- FDP capabilities to support Free Route flight plan handling;
- FDP system interconnection to facilitate tactical trajectory management;
- Interface between ASM system and ATC system in order to provide the correct airspace configuration to the controller's working position;

This demonstration will assess the benefit of Flexible Airspace Management and Free Route to improve ATM Network performance; it will serve as Proof of Concept for AF#3 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- The Network Manager platform at the level of pre-operational or operational status to support the Proof of Concept.
- At least 3 ATS platforms at the level of pre-operational or operational status to support the Proof of Concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation these are:

- Direct Routing:
    - The ASM support system shall support the fixed and conditional route networks currently in place, as well as DCTs, FRA and flexible sector configurations; The system shall be able to respond to changing demands for airspace; Enhancements to the Network Operations Plan (NOP) shall be achieved through a cooperative decision-making process between all involved operational stakeholders; The system shall support cross-border activities, resulting in shared use of segregated airspace regardless of national boundaries
    - Airspace configurations shall be accessible via Network Manager systems, which shall contain the up-to-date and foreseen airspace configurations, to allow airspace users to file and modify their flight plans based on timely and accurate information
    - The ATC system shall support flexible configuration of sectors so that their dimensions and operating hours can be optimised according to the demands of the NOP — The system shall allow a continuous assessment of the impact of changing airspace configurations on the network
    - ATC systems shall correctly depict the activation and de-activation of configurable airspace reservations and the change of a volume of airspace from a fixed route network to FRA
    - The Flight Plan Processing System (IFPS) shall be modified to reflect the changes in the definition of airspace and routes so that the routes, flight-progress and associated information are available to ATC systems
    - The ASM, ATFCM and ATC systems shall securely interface in a way that allows the

provision of air navigation services based on a common understanding of the airspace and traffic environment. The ATC systems shall be modified to enable this functionality to the extent necessary to comply with Regulation (EC) No 552/2004

  - Centralised Aeronautical Information Services (AIS) systems, such as the European AIS Database (EAD), shall make available environment data for flexible airspace structures to all involved operational stakeholders in a timely manner. This enables planning to be undertaken based on accurate information relevant to the time of the planned operations; Local AIS systems shall enable this capability and the upload of changing local data
  - Operational stakeholders shall be able to interface with the NOP as specified in Point 4; Interfaces shall be defined to allow dynamic data to be sent to operational stakeholder systems, and for those stakeholders to be able to communicate information in an accurate and timely manner; The systems of these stakeholders shall be modified to enable these interfaces

- Free Route:
  - Network Management systems:
    - Flight plan processing and checking for DCTs and FRA
    - IFPS routing proposals based on FRA
    - Dynamic re-routing
    - ATFCM planning and execution within FRA — calculation and management of traffic loads
  - ATC systems:
    - Flight data processing system, including HMI, to manage trajectory/flight planning without reference to the fixed ATS network
    - Flight planning systems to support FRA and cross-border operations
    - ASM/ATFCM to manage FRA
    - For FRA, Medium Term Conflict Detection (MTCD) including Conflict Detection Tools (CDT), Conflict Resolution Assistant (CORA), Conformance Monitoring, and APW for dynamic airspace volumes/sectors; Trajectory prediction and de-confliction shall support an automated MTCD tool adapted to operate in FRA airspace and, when required, on DCT
  - ATC systems may receive and utilise updated flight data coming from an aircraft (ADS-C EPP) where data link functionality is available
  - Airspace users' systems shall implement flight planning systems to manage dynamic sector configuration and FRA
  - Flight Data Processing System (FDPS) shall support FRA, DCT and A-FUA
  - The controller working position shall support the operating environments, as appropriate

Contextual Information

Free Route Airspace Operations

In alignment with ICAO aviation system block upgrades, (the Framework for global harmonization, working document for GANIS), free routing corresponds to the ability for flights to file a flight plan with at least a significant part of the intended route which is not defined according to published route segments but specified by the airspace users. It is a user-preferred route, not necessarily a direct route, but the flight is supposed to be executed along the direct route between any way-point specified by the airspace user (published or not). Free Route operations could only be performed within a Free Route Airspace.

Free Route Airspace (FRA) is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point with the possibility to route via intermediate way points without ref. to the ATS route network, subject to airspace availability. The FRA is a fully managed airspace within which flights remain subject to ATC.

Free Route operations concern flights in cruise or vertically evolving within this airspace. The user preferred route 2D design will be based on published Entry and Exit points of the free route airspace. The publication of a constellation of published reference waypoints may be studied. Airspace users can freely define additional intermediate waypoints, by using Latitude/longitude coordinates (Entry and Exit points excluded, a user preferred route may be entirely defined via non published waypoints).

The mandatory Entry and Exit points are defined in order to ensure a safe transition between Free Route and predefined route constrained environments, so a lateral or vertical connection between the user preferred route and the adjacent/subjacent ATS Route Network. This has been also facilitated via ARN design refinement.

Every Airspace user defines its user preferred trajectory according to its business intentions, which will strongly differ according to the operator type and business model (e.g. low cost airline or business aviation company) , and even according to the air link for a same operator (e.g. market competition & cost index, route charges, yield management).

According to the situation, the performance target and the associated design criterion will not be the same:

- time saving,
- distance flown reduction,
- fuel consumption reduction,
- yield management (e.g. hub management, flight crew turnover).

Consequently, the preferred route design may strongly vary. It can consists of:

- a single direct segment linking an entry point to an exit point (i.e. route length reduction), or
- a set of successive direct segments freely (still defined between two published Entry and Exit points), linking published or non-published (computed) waypoints (e.g. flight management using wind benefits). There is no limitation, every published or non-published (computed) waypoint may be directly linked to any other one, within the FAB Free Route Airspace.

As already mentioned, a fixed route network may locally and temporarily be activated within the Free Route Airspace, due to major operational constraint. Therefore the preferred route may occasionally contain predefined route based chapter(s).

Advanced Flexible Use of Airspace - AFUA

The concept of AFUA intends to provide more flexibility by allowing dynamic airspace management in all phases of the operations, from initial planning to the execution phase, taking into account local traffic characteristics.

AFUA structures are designed to fulfil military needs and better share the constraints with other airspace users.

A modular design of airspace reservation/restriction, Variable Profile Areas (VPA) for new airspace requirements is introduced to enable sub-divisions, new areas or revised airspace requirements closer to air bases (≤100 NM radius) and define different airspace scenarios to address local, sub-regional and network impact. A VPA can be any type of airspace reservation or restriction consisting of either individual or a combination of volumes / modules.

The basic unit volume of a VPA could be defined according to the following principles:

- the construction of the VPA shall allow the maximum of flexibility and offer several combinations that can fit the airspace users' needs,
- smaller basic unit volume provide more flexibility, particularly interesting in a high density traffic area e.g. 10x10 NM,
- vertical limits shall be adaptable depending on the mission type, mission objectives, aircraft capabilities, etc.,
- any combination of basic volume is possible,
- the status (TRA, TSA, D or R) shall be adapted to the mission,
- the route network associated with the VPA has been taken into account in the area design to enable capacity optimization and different airspace allocation and rerouting scenarios.

For specific missions and under certain circumstances, fixed airspace structures will remain, including ATS Route, CDR and ARES due to safety, security, environmental or legal constraints.

Airspace reservations are fully embedded in the trajectory and negotiated through collaborative decision making process (A-CDM), limited to the individual operational need by the implantation of modular areas. The possibility to design ad-hoc structure delineation at short notice is offered to respond to short-term airspace users' requirements not covered by pre-defined structures and/or scenarios. Changes in the airspace status are uplinked to the pilot and shared with all other concerned airspace users by the system. GAT crossing are possible in all type of airspace structures, after coordination or under specific permanent agreements, depending on the nature of the airspace. Nevertheless the penetration into a TSA-type or Prohibited-type of Airspace, shall only be intended to cover urgent situations and not as a common authorisation.

The continuous sharing of airspace planning and status between all ATM actors should limit the number of unnecessary constraints.

Automated processes are in place at ground and airborne levels (Wing Ops, Air Traffic Control (ATC) Systems, Airspace management Cell (AMC), Air defence Centres, Aircraft Equipage, etc.) in order to make the Mission Trajectory execution consistent with airspace allocation process (ARES activation/deactivation displayed in real time on CWP displays)

Essential prerequisites

There are no essential prerequisites for this VLD.

Deliverables

- Demonstration Plan
- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Variable profile military reserved areas and enhanced (further automated) civil-military collaboration
- Free Route through the use of Direct Routing
- Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level (coordination with SESAR 2020 PJ.06.01 required)
- Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing
- Automated Support for Dynamic Sectorisation
- Extended Flight Plan

Potential cooperation opportunities with other Demonstration projects

- Network Collaborative Management
- Flight Information Exchange

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are “certified” against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this “early” SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.
- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.4 Advanced Air Traffic Services – Arrival Management Extended to En-Route Airspace (PJ25)

Title: PJ25 - Arrival Management extended to en-route Airspace

Demonstration overview

Arrival Management extended to en-route Airspace extends the AMAN horizon from the 100-120 nautical miles to 180-200 nautical miles from the arrival airport. Traffic sequencing may be conducted in the en-route and early descent phases. Air traffic control (ATC) services in the TMAs implementing AMAN operations shall coordinate with Air Traffic Services (ATS) units responsible for adjacent en-route sectors.

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge "industrial research" and "deployment" related to the PCP ATM Functionality 1 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of connected SESAR high-technology demonstration platforms in relation to the "Advanced Air Traffic Services" key feature of the SESAR 2020 programme. This VLD shall aim at a minimum at a demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of additional end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will run in parallel.

This Wave 1 VLD is focused on demonstrating how optimised arrival constraints can be passed to aircraft and the subsequent benefits achieved by aircraft meeting them. The VLD objectives are likely to include the following:

- 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.

- Passing arrival constraints to preferably two or more upstream ACCs to demonstrate how aircraft can meet the constraint and the technical and operational issues regarding the aircraft and ANSPs associated with this process.

This demonstration will assess the benefit of Arrival Management extended to en-route Airspace to improve ATM Network performance; it will serve as Proof of Concept for AF#1 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- At least two TMA and associated en-route sectors platforms at the level of pre-operational or operational status to support the Proof of Concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation:

- AMAN systems shall provide arrival sequence time information into en-route ATC systems up to 180-200 nautical miles from the arrival airport

- ATC systems of upstream air traffic service (ATS) units shall manage AMAN constraints. Data exchange, data processing and information display at the relevant controller working positions in the ATS units shall support the management of arrival constrains; Data exchange between ATS units may be achieved with existing technology pending the implementation of System-Wide Information Management (SWIM) services

Contextual Information

AMAN and Extended AMAN horizon

AMAN functionality is extended to support the management of arrival flows further out from the destination airport. The AMAN process is, by its nature, a process that starts from a first come-first served unbiased sequence. As the sequencing algorithm progresses, the optimisation of the natural sequence is adapted in order to maximise the throughput in the constrained environment.

The sequencing algorithms of the system may include generic functions for optimising the runway throughput, such as wake vortex class, approach speed categories and runway occupancy times.

If required, a Controlled Time Of Arrival (CTA) that is an ATM imposed time constraint on a defined metering point associated to an arrival runway can be generated. It is generally calculated after the flight is airborne and is used by the relevant Controllers and Flight Crews. For a short flight the CTA should be very close to the pre-take-off TTA. For longer flights the CTA must be available well before planned Top-Of-Descent and is calculated when the flight passes inside the AMAN sequencing horizon.

The introduction of aircraft capable of flying highly accurate 4D trajectories, improves the performance and reliability of the AMAN system. This gives better performance in the sequencing and scheduling of the arrival stream as well as higher potential for the aircraft to fly optimised trajectories at speeds and descent rates that will save fuel, reduce noise and at the same time provide all stakeholders with higher predictability. The capable aircraft affected by a constraint receives a CTA in the En Route phase of flight, thereby being able to adjust its trajectory in the most efficient way up to the CTA metering point, while passing through several ATC sectors/units.

In those ATS Units where the precision trajectory, as sent by the properly equipped aircraft according to contract terms (e.g. through ADS-C EPP) can be processed and when the level of saturation requires the implementation of constraints, the AMAN system computes and allocates CTA, when required, to capable aircraft on the basis of the ETA min/max provided by the aircraft on ATC request.

AMAN also calculates target (approach) times (applicable to non-I4D/CTA capable aircraft), ensuring the implementation of an efficient sequence of arrival to the entire traffic flow (which may be merging via multiple converging routes). AMAN calculated times are presented to Controller, who assesses the possibilities to accommodate the delay/part of delay in his sector through speed change/track extension or early descend. If no possibility to accommodate delay, the flight is managed by downstream sectors and/or through holding instructions.

Essential prerequisites

There are no essential prerequisites for this VLD. An existing AMAN facilitates the operational integration of this ATM functionality into existing systems.

Deliverables

- Demonstration Plan

- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Extended Arrival Management (AMAN) horizon
- Optimised Route Network using Advanced RNP

Potential cooperation opportunities with other Demonstration projects

- Enhanced Terminal Airspace using RNP-Based Operations
- Flexible Airspace Management and Free Route
- Flight Information Exchange
- Initial Trajectory Information Sharing

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are “certified” against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this “early” SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as

such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.

- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global "vitrine" for European leadership in ATM. The key headline to articulate the communication plan is "to see is to believe". To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.5 Advanced Air Traffic Services – Enhanced Terminal Airspace using RNP-based Operations (PJ26)

Title: PJ26 - Enhanced Terminal Airspace using RNP-Based Operations

Demonstration overview

Enhanced Terminal Airspace using RNP-Based Operations consists of the implementation of environmental friendly procedures for arrival/departure and approach using PBN in high-density TMAs.

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge “industrial research” and “deployment” related to the PCP ATM Functionality 1 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of sustainable SESAR high-technology demonstration platforms in relation to the “Advanced ATS Services” key feature of the SESAR 2020 programme. This VLD shall aim at minimum at a SESAR system demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of these end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will run in parallel.

This VLD shall include the development of procedures for testing that are aligned with the following navigation specifications:

- SIDs and STARs using RNP 1 specifications with the use of Radius to Fix (RF) path terminator.
- Required Navigation Performance Approach with Approach Procedure with Vertical Guidance (RNP APCH with APV).

Enhanced Terminal Airspace using RNP-Based Operations includes:

- RNP 1 SIDs, STARs and transitions (with the use of Radius to Fix (RF) attachment)
- RNP APCH (Lateral Navigation/Vertical Navigation (LNAV/VNAV) and Localiser Performance with Vertical guidance (LPV minima).

This demonstration will assess the benefit of PBN to improve ATC operations in high-density TMAs; it will serve as Proof of Concept for this sub-functionality of AF#1 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- A minimum two TMA platforms compliant with the requirements set-out above to support the Proof of concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation ATC systems and ATC Safety Nets shall enable the Terminal Area and Approach PBN operations:

- RNP 1 operations require the Lateral and Longitudinal Total System Error (TSE) to, be within +/– 1 nautical mile for at least 95 % of flight time and on-board performance monitoring, alerting capability and high integrity navigation databases

- For RNP APCH, the Lateral and Longitudinal Total System Error (TSE) shall be +/– 0,3 nautical mile for at least 95 % of flight time for the Final Approach Segment and on-board performance monitoring, alerting capability and high integrity navigation databases are required
- RNP 1 as well as RNP APCH capability requires inputs from Global Navigation Satellite System (GNSS)
- Vertical Navigation in support of APV may be provided by GNSS Satellite Based Augmentation System (SBAS) or by barometric altitude sensors

Contextual Information

Required navigation performance (RNP) RNP is a statement of navigation position accuracy necessary for operation within a defined airspace. It establishes highly refined parameters for aircraft airspace containment including navigation performance accuracy within which the aircraft's navigation system is expected to remain 95% of the time. And the integrity of the system assures pilots they will remain within the containment area. This is accomplished by an aircraft's RNP-capable flight management system (FMS) which utilize enhanced software to monitor sensor inputs and compare real time navigation accuracy, also referred to as Actual Navigation Performance (ANP). Navigation performance for a particular RNP type is expressed numerically. Depending on the capability of each aircraft's system, RNP values can be as low as 0.1 nautical miles. A performance value of RNP 0.3, for instance, assures that the aircraft has the capability of remaining within 0.3 nautical miles to the right or left of the centerline 95% of the time and within a linear containment area of 0.6 nautical miles (twice the RNP value) 99.999% of the time.

Operational Advantage of RNP

The accuracy and integrity monitoring of RNP can provide more precision than conventional RNAV procedures. Aircraft with the more capable authorized systems will be able to operate into airports where current instrument approach procedures, because of specific constraints, must be designed with high landing minimums. RNP Decision Altitudes (DAs) can be as low as 250 feet with visibilities as low as three quarters of a mile. Besides lower minimums, the benefits of RNP include improved obstacle clearance limits as well as reduced pilot workload. And by having RNP-capable aircraft fly an accurate, repeatable path, ATC can be confident that these aircraft will be at a specific position, thus maximizing safety and the efficient flow of aircraft through the airspace.

Radius to Fix Legs (RF LEGS)

To attain these benefits, a key component of RNP approach procedures are curved flight tracks. Constant radius turns around a fix are referred to as RF legs (or Radius-to-Fix legs). These turns, encoded into the navigation database, allow the aircraft to avoid critical areas of terrain or conflicting airspace while maintaining positional accuracy by maintaining precise, positive course guidance along the curved track.

The introduction of RF legs into the design of terminal RNAV procedures will result in improved use of airspace and allow procedures to be developed to/from runways that are otherwise limited to traditional linear flight paths – or in some cases – not served by an IFR procedure at all. Navigation systems with RF capability are a pre-requisite to flying a procedure which includes an RF leg.

Although TMAs are still reliant on fixed route structures, they are optimised through Performance Based Navigation (PBN) using Advanced RNP. Advanced RNP is proposed as an ECAC-wide navigation specification to be used in En-route as well as Terminal airspace and to cover all phases of flight. This overarches the separate elements of P-RNAV and RNP APCH and is supported by a new EASA AMC (Acceptable Means of Compliance (for airworthiness of products, parts and appliances) for Advanced

RNP.

Essential prerequisites

There are no prerequisites for this VLD.

Deliverables

- Demonstration Plan
- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Enhanced terminal operations with LPV procedures
- Enhanced terminal operations with automatic RNP transition to ILS/GLS
- Enhanced Terminal Airspace for RNP-based Operations

Potential cooperation opportunities with other Demonstration projects

- Arrival Management extended to en-route Airspace

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are “certified” against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this “early” SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.
- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.6 Enabling Aviation Infrastructure – Initial Trajectory Information Sharing (PJ31)

Title: PJ31 - Initial Trajectory Information Sharing

Demonstration overview

This VLD will demonstrate the first steps towards improved predictability at both Network and local level through the improved use of target times and trajectory information. The sharing and use of on-board 4D trajectory data by the ground ATC system will result in improved predictability. This improved predictability of aircraft trajectory will benefit both airspace users and ANSPs and is expected to have positive impact on fuel saving and reduction of delay variability.

This VLD will help prepare the environment (anticipating the full scale deployment under the responsibility of the SESAR Deployment Manager) for initial 4D (i4D) and the later use of Controlled Time of Arrival (CTA) and Controlled Time Over (CTO) although these two last elements remain outside the scope for this VLD as they are not sufficiently mature at this stage.

Initial Trajectory Information Sharing – Initial 4D (i4D) consists of the improved use of target times and trajectory information, including where available the use of on-board 4D trajectory data by the ground ATC systems and Network Manager systems, implying fewer tactical interventions and improved de-conflicting. The predicted trajectory can be synchronised between the ground system and the aircraft by the downlink of trajectory data between equipped aircraft and service providers that are able to incorporate this information into their Flight Data Processing System (FDPS). Furthermore improved interoperability between the ground systems of adjacent Air Traffic Service Units (ATSU) shall enable better exchange of the trajectory data supporting better coordination between centres, extending the horizon where ground trajectory prediction tools can meet the accuracy requirements that are necessary for them to be used for advanced Air Traffic Management (ATM) service provision.

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge “industrial research” and “deployment” related to the PCP ATM Functionality 6 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of sustainable SESAR high-technology demonstration platforms in relation to the “Enabling Aviation Infrastructure” key feature of the SESAR 2020 programme. This VLD shall aim at a minimum at a SESAR system demonstration in a close-to-operational environment including the preparation and platform availability to support demonstrations in targeted operational environments involving end-users. The involvement of these end-users to perform the related operational demonstration will be contracted through open calls that will be awarded in a second step and will be run in parallel.

This VLD shall illustrate the combination and synchronization of key PCP Air and Ground functionalities in order to demonstrate how improved consistency between air and ground trajectories through the air-to-ground down-linking of trajectory data enhances the overall performance of ATM (e.g. Separation Service delivery, Traffic Synchronisation).These ATC operations are at the heart of ground-based systems developed by SESAR. The use of downlinked airborne data allows for more precise anticipation of the air traffic situation, which reduces the need for tactical intervention.

Maximum benefit are expected be realised for trajectory prediction for the climb and descent phases of flight, because airborne 4D trajectory information will allow the ATM system to plan against each individual aircraft’s updated speed schedule plan, which often needs to be changed during the execution phase due to changes in the operational environment (e.g. Top-Of-Descent (TOD) variability, MET factors, updated 2D route). Execution-phase airborne speed schedule updates are currently not exchanged with the ground ATM infrastructure. ANSPs are consequently forced to work with trajectory prediction based on pre-departure speed schedules only. In particular, use of airborne 4D trajectory data in ground trajectory prediction feeding an Extended Arrival Manager (E-AMAN) will result in more stable arrival planning, which will benefit not only the ANSP, but also the airport hence overall network performance.

The demonstration shall involve at minimum one ground platform that is able to receive the airborne trajectory downlink from aircraft flying in its area of responsibility, display the downlinked profile on the Controller Working Position (CWP) and integrate it in their trajectory prediction FDPS processes in order to enhance the performance of Air Traffic Control (ATC) tools (e.g. E-AMAN, Planning Controller (PC) and/or Tactical Controller (TC) support tools). The enhanced Trajectory Predictor developed for this demonstration may use, in addition to airborne predicted 4D trajectory information, down-linked from real flights based on the ADS-C standard ED228-ATN B2. When available, improved data from other sources where available. This may include a combination of:

- Adequate wind & temperature data provided to A/C for accurate airborne computations of EPP,
- Extended Flight Plan data (from FOC - Flight Operational Centre).

The equipped aircraft shall down-link trajectory information using ADS-C Extended Projected Profile (EPP) as part of the ATN B2 services (ED228); trajectory data shall be automatically down-linked from the airborne system shall update the ATM system according to the contract terms. Data link communications ground systems shall support ADS- C (downlink of aircraft trajectory using EPP) as part of the ATN B2 services. Flight data processing systems, controller working position and Network Manager systems shall make use of downlinked trajectories. Downlinked trajectories may be made available to neighbouring ANSPs and NM through the use of the Flight Object script where available.

This demonstration will assess the benefit of using real flights Aircraft Information to improve the ATC operations in at least one ground industrial platform in a close to operational environment; it will serve as Proof of Concept for AF#6 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- A minimum of one airborne platform at the level of revenue flight equipage to support the Proof of concept.
- At least one ground Platform at the level of pre-operational or operational status to support the Proof of Concept.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. These are by regulation:

- Equipped aircraft shall down-link trajectory information using ADS-C Extended Projected Profile (EPP)as part of the ATN B2 services; The trajectory data shall be automatically down-linked from the airborne system shall update the ATM system according to the contract terms
- Data link communications ground systems shall support ADS-C (downlink of aircraft trajectory using EPP) as part of the ATN B2 services
- Flight data processing systems controller working positions and Network Manager systems

shall make use of downlinked trajectories

- FDP to FDP trajectory exchange between ATS units as well as between ATS units and the Network Manager systems shall be supported using flight object exchange

Contextual Information

The Trajectory Management concept entails the systematic sharing of aircraft trajectories between various participants in the ATM process to ensure that all partners have a common view of a flight and have access to the most up-to-date data available to perform their tasks.

This concept enables the dynamic adjustment of airspace characteristics to meet predicted demand with distortions to the business/mission trajectories kept to the absolute minimum. Whenever possible, the necessary tactical interventions are considered at the gate to gate trajectory level and not only at sector level, taking due account of the wider impact on the trajectories concerned as well as on the network.

The optimisation of the ATM network, leading to minimal distortions of the trajectories, is achieved through an extensive iteration process based on the exchange of accurate data and refined estimates of all involved actors.

Business and Mission Trajectory

Initial trajectory based operation in SESAR 1 reflects the development of a User Preferred 4D Trajectory, or from a Military perspective the Requested Mission Trajectory from long term planning through all phases of flight until reaching the stand after landing. It is an intermediate step towards 4D Trajectory Operations that encompasses the sharing of air and ground trajectory data driving safe and predictable operations with improved situational awareness amongst actors as well as the possibility during execution phase to impose a single time constraint at a time over a defined fix to a flight.

The application of initial 4D trajectory operations is improved by the use of the Airline operational flight plan and its equivalent for OAT which are more detailed than the ATC flight plan and require pre-planning and prior knowledge of flight intent as well as static and dynamic constraints in the ATM system (airspace reservations, capacity short falls, weather, etc.).

During the execution phase, equipped aircraft are able to share their onboard trajectory according to contract terms specified by ATC (e.g. ADS-C EPP) to feed the ground tools, including the trajectory prediction and thereby improve accuracy and predictability.

Where and when required, single time constraints (Controlled Time Over, Controlled Time of Arrival (CTO/CTA) may be allocated to equipped aircraft on the basis of the estimated time window computed onboard the aircraft for the metering fix specified by ATC, supported –for CTA- by AMAN using air ground data link.

Situational awareness and predictability are progressively improved thanks to the exchange of information between ATC facilities, which include the Network Management trajectory related information.

Initial trajectory based operation focuses predominantly on the flight phases when the aircraft is within the AMAN horizon, i.e. the last part of the cruise phase before Top of Descent and the descent phase. However Network Management and ATS Units having data exchange in earlier flight phases have synchronised the air ground view and are already beginning to sequence traffic through metering points ensuring orderly flows that facilitates the use of CTO or CTA.

For military flights from/to military airfields not subject to capacity issues, the use of CTA is not crucial. Nevertheless, the use of CTO at entry/exit points of airspace reservation/restriction (ARES) facilitates the accuracy of their real-time activation/de-activation, and consequently improves Network performance through better management of static constraints.

The 4D operations concept is based on two distinct elements:

- Synchronisation between air and ground 4D trajectory which is addressed here in the context of this operational package “moving from airspace to trajectory management”
- Strategic metering and sequencing of flights using CTO or CTA when and where required (e.g. in constrained airspace) which is addressed further in the document in the operational sub-package “end to end traffic synchronisation”.

System Interoperability with air and ground data sharing

The ATM system relies on all actors having a shared view of the situation; it is therefore essential that the trajectory held on the ground in the ground trajectory prediction tools, in the Flight Data Processing Systems (FDPS) and in the wider Network systems is as close as possible to the trajectory held in the aircraft Flight Management System (FMS).

Improved consistency between air and ground trajectories through down linked trajectory data enhances the overall performance of decision support tools. Congestion can be more precisely anticipated, allowing better adaptation to real traffic situation and therefore reducing the need for tactical intervention. Before departure, the Airspace User, having provided its operational flight plan, refines, in coordination with the Network Management, the trajectory to be flown, taking due consideration of all the known constraints affecting the flight. For flights entering the ECAC airspace, this coordination may be conducted the traditional way through the issuing of ATC clearances.

In the execution phase, the predicted trajectory can be synchronised according to the contract terms specified by ATC (e.g. ADS-C EPP) allowing the automatic downlink of trajectory data between equipped aircraft and the ANSP that are able to incorporate these data in their system.

Improved interoperability between the ground systems of adjacent ATSU enables better exchange of the trajectory data with enhanced accuracy, at an earlier stage than today, supporting better coordination between centres, extending the horizon of the ground trajectory prediction tools.

The down linked trajectory data consists of the Extended Projected Profile (EPP) which include:

- The Flight Intent (input to aircraft FMS) i.e. the waypoints of the routes and associated altitude, possible time and/or speed constraints agreed between ATM actors.
- The Predicted Trajectory (output from aircraft FMS) i.e. the Flight Intent augmented with intermediate waypoints and associated altitude, time and speed estimates computed by aircraft FMS to build the lateral transitions and vertical profiles.
- Aircraft derived parameters e.g. gross weight, speed min/max, etc.

The trajectory data are automatically down linked according to the datalink contract terms:

- On event (e.g.: in case of change of predicted trajectory versus previously shared predicted trajectory more than the thresholds specified by ANSP))
- On request
- On a periodic basis.

These updates of the trajectory are automatically performed from the aircraft system to the ANSP system according to the contract terms. They feed the ground tools, increasing the accuracy of the ground computed trajectory and allow potential conflicts within a medium-term time horizon to be identified and resolved earlier thus reducing the risk of unexpected events.

During the execution phase, the trajectory may be revised at controller or Flight Crew initiative (e.g. due to traffic or weather hazards, for fine sequencing using CTO/CTA or due to aircraft inability to meet a constraint). Each revision of the trajectory triggers a trajectory update message (e.g. ADS-C EPP) enabling a re-synchronisation of the trajectories held in the air and on the ground.

This “trajectory revision” consists of a “closed loop” in that the ATC instruction revising the trajectory modifies the route and/or associated constraints in a closed manner, e.g. a direct from a point of the trajectory to another point of the trajectory.

“Open-loop” instructions are still used by Controller in time critical situations e.g. to ensure immediate separation of the aircraft versus conflicting traffic or to avoid adverse weather (CBs). These “open loop” instructions do not provide Flight Crew with instructions on how to return to the initial trajectory. Neither do they contain instructions on how to proceed with another trajectory enabling him to complete his flight. After an open-loop instruction the adherence to the initial trajectory is suspended onboard until a new instruction is given to resume a “closed loop” trajectory. The reduction of tactical open-loop interventions is one of the advertised benefits of trajectory operations. It should be achieved thanks to better sharing of up-to-date and precise data among all stakeholders enabling anticipation of the problems followed by the implementation of collaborative solutions.

Towards VLD

The SESAR concept is based upon the fundamental element of trajectory sharing. The ultimate goal is a trajectory based ATM system where actors optimise business and mission trajectories through common 4D trajectory information taking into account users priorities and ATC constraints. The objective is the sharing of the trajectories between the ATM actors including Airspace Users through an iterative process to take into account more accurate data once available (e.g. intentions, MET forecast, current traffic, airspace management). This will allow the Airspace User to choose the preferred way of integrating ATM constraints when required.

In order for SESAR to deliver the benefits envisaged, it is essential to understand the many inter-dependent factors, often creating conflicting priorities between an individual Airspace User and the wider ATM network.

Work done in SESAR 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 were developed to enable trajectory negotiation among FMP’s, airline users and other actors, but trajectories resulting from STAM’s or other revisions need to be shared by all ground actors before being executed.
- 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
- Improvement of ATC interoperability during the pre-planning and execution phases of the flight

The VLD will intend to answer to the need to improve integration between these 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 in SESAR 1, but these do not translate automatically in shared updated trajectory predictions when they concern flight already in execution.

Today, ATM constraints are managed differently by FOC/WOC, NM and ATC's. Information is shared through various documents exchanges (AIC, RAD's, information on LOA's), but each system manages them differently. The new ATM Solutions proposed in SESAR will need better trajectory predictions and additional data exchanges between systems. The trajectory prediction will need to factor in the level of uncertainty that underlies the data that are used (e.g. aircraft position, weather, aircraft navigation) and will provide to ATC tools data associated to confidence levels.

The ambition of new ATM Solutions is to manage a gate-to-gate trajectory, thus the surface (taxi) trajectory needs to have greater coherency with the airborne part of the trajectory, through better coordination of the stakeholders and systems.

Inconsistencies between various sources for aeronautical (AIM) and meteorological (MET) information will be further removed and so that AU, NM and ATC are enabled to establish a common operating picture with respect to the available infrastructure [AIM] and also the meteorological conditions [MET].

Extended Projected Profile notion introduction

If the ground's view of a flight main component is the Flight Object, the number of stakeholders and their need of up to date trajectory data throughout the flight is leading to a necessary real-time ground/ground coordination which may have an impact on-board.

The Extended Project Profile (EPP) is the aircraft intent provided by a new WG78/SC214 standard for Automatic Dependent Surveillance – Contract (ADS-C).

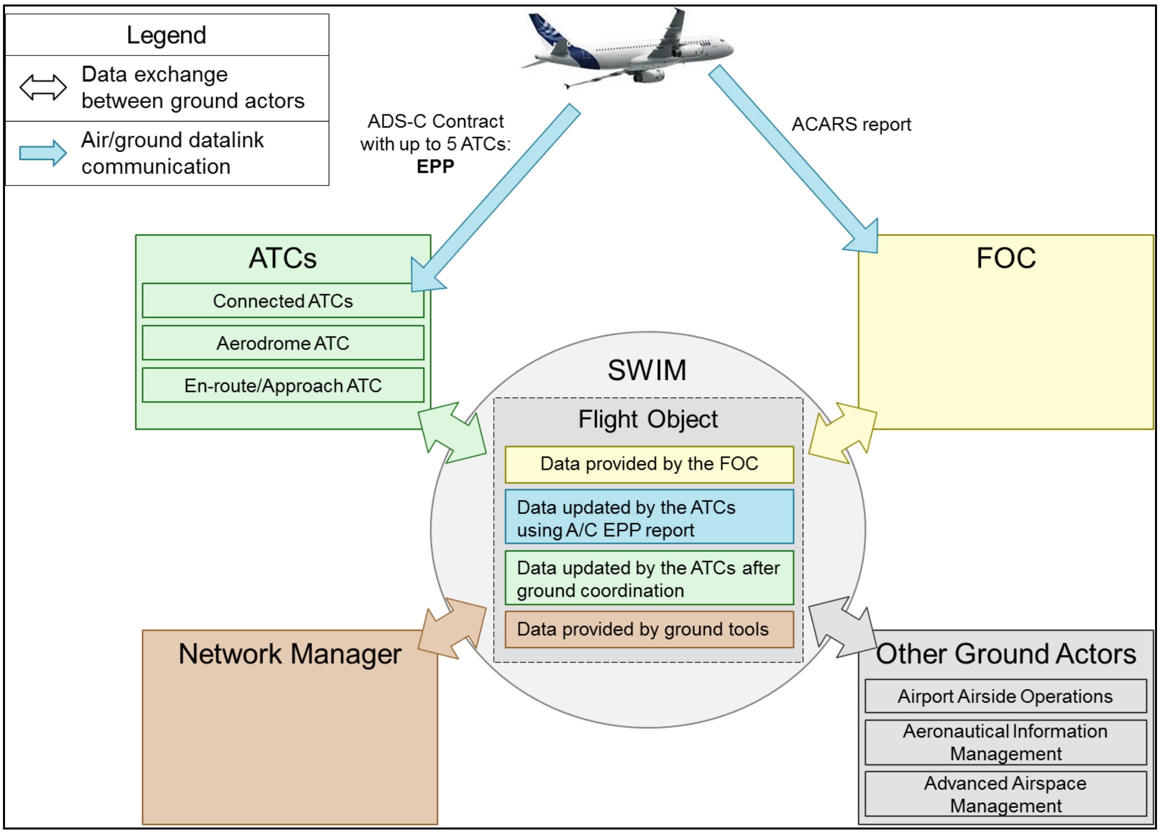
The information provides the intent data for up to 128 future waypoints in four dimensions. In addition information such as the gross mass and minimum/maximum speeds is also made available.

This data can be made available through a contract set up between the ground and air systems either on demand, periodically or triggered by an event.

The data contained in the downlink is:

- Projected Profile – predicted position, level and time of next and next plus one waypoint;
- Ground vector track – ground speed and rate of climb or descent;
- Air vector heading – mach or IAS, and rate of climb or descent;
- Projected profile predicted position – level and time of the next and the following waypoint;
- MET data – wind direction and speed, temperature and turbulence (if available);
- Extended projected profile type – trajectory intent status, level constraints, RTA value, speed constraint, current gross mass, crossover level, predicted position, level and time;
- Emergency/urgency status – emergency or urgency status, including emergency, unlawful interference;
- TOA range – earliest, latest and current ETA at the specified waypoint;
- RTA status data – earliest, latest and current ETA at the specified waypoint and achievable/non-achievable'

Speed schedule profile – predicted gross mass at top of descent, normal speed, min/max speeds for climb, initial cruise at top of climb, final cruise at top of descent and the descent.



ATC Management of the Extended Projected Profile – Use Cases

This section describes use cases for the synchronisation of flight information between air and ground systems following the downlink of an Extended Projected Profile (EPP) from a suitably equipped aircraft and the subsequent use of EPP information to improve the trajectory in the ground system.

These use cases are expected to be applicable only to air traffic operating between capacity constrained airports.

The use cases covered are:

- The establishment of the ADS contract to obtain the EPP, and the provision of the EPP to downstream ATSUs
- The consistency check of flight intent performed upon reception of a new EPP
- The resolution of a discrepancy in the route held between the air and the ground trajectories
- The synchronisation of level constraints held between the air and the ground trajectories to support extended arrival management procedures
- The use of EPP information to improve ground trajectory prediction

The synchronisation of the trajectory between air and ground systems is an ideal precursor activity to further elements of the i4D service, such as the agreement of a time constraint (e.g. a controlled time of arrival) between the air and ground. Additionally, the synchronisation of the flight intent between the air and ground (including ATC procedures, such as the STAR), is necessary for the airborne TP to produce reliable estimates in either the EPP or ETA min/max.

Scenario Summary

Today's ATM system makes extensive use of trajectory predictions, both in air and ground systems.

However, ground system predictions of an aircraft's trajectory made by ATC may exhibit significant differences to the corresponding prediction made by the aircraft FMS. One of the contributory reasons to this is the lack of accurate input data to the ground TP, such as the mass of the aircraft and the optimised speed schedules chosen by the airspace user for climb and descent. This lack of accurate inputs results in large uncertainties, which in turn reduce the capacity of ATSUs to handle more aircraft.

Predictions made by the FMS, however, whilst having the potential to be more accurate, are often made without knowledge of all the constraints that are imposed for ATC purposes. Thus, the FMS prediction is often not the trajectory that is actually flown by the aircraft. Both air and ground systems are not always synchronised with the same intent. Additionally, the wind data that is made available to the FMS is typically not as detailed as that used by the ground (i.e. the meteo model is not as granular) and may not be updated as frequently. The wind data is considered as the primary source of error to the FMS trajectory prediction. Note that the FMS uses actual wind data in the vicinity of the aircraft, which improves short-term FMS predictions.

Under SESAR trajectory management operations, suitably equipped aircraft can share trajectory information from the FMS with ATSUs. This enables ATSUs to check if the air and ground are synchronised with respect to the route and constraints and to take suitable corrective action to align the intent if and when required. A synchronisation of intent between the air and ground trajectories is considered as an ideal prerequisite for some further trajectory based operations, such as the allocation of a time constraint. The information shared from the FMS provides the ground TP with more accurate inputs that should allow for a reduction in operational uncertainties associated to the future aircraft trajectory.

Before a suitably equipped aircraft enters the area of responsibility of C-ATSU, the ATC system establishes an ADS-C contract with the flight in order to downlink FMS trajectory information through the Extended Projected Profile (EPP). The ADS contract can specify the information and the way in which it is downlinked; this may be: on demand, on a periodic basis, or on event (such as when the new EPP differs from an initial baseline report by more than defined thresholds).

The aircraft system is capable of supporting contract requests with at least four ATSUs simultaneously. It is also capable of supporting one demand, one event and one periodic contract request with each ATSU simultaneously. However, trajectory based operations may require parameters in reports which are not necessary for other ADS-C users. Therefore, it is considered important that ATSUs coordinate the parameters, reporting interval, event requirements and contract cancellation so that different users are able to successfully use ADS-C.

Where C-ATSU is not equipped, or unable, to establish an ADS-C contract with the aircraft, that ATSU will request the provision of EPP service from another capable ATSU. This could be a downstream ATSU, a previous controlling ATSU or a 3rd party ATSU.

Upon reception of the EPP, the receiving ATSU makes the EPP available to the current and downstream ATSUs.

The C-ATSU then checks the consistency of the 2D route and constraint information in the EPP against the ground-agreed trajectory for the IOP area, if it is capable of doing so and has agreed to support i4D operations (e.g. as defined in LOA between ATSUs). If the C-ATSU is unable to perform the check itself, it will request the service from another ATSU that can provide the checking service.

If the ground detects a discrepancy in the route, an alert is provided to the controller in the ATSU responsible for the AoR where the discrepancy occurs, so that they may form a plan (coordinating with others, if required) and take the necessary actions to resolve it. As part of agreed arrival management procedures, some controllers may also assess the level constraints in the EPP against those of the ground plan. If required, the controller may uplink a revised route clearance along with the level planning constraints required by the arrival management procedure to the aircraft.

For any change to the route or constraints proposed by the ground, the flight crew will assess the new flight plan and the implications of the proposed trajectory on the further progress of the flight and WILCO the message if acceptable.

The air and ground systems are now synchronised in their flight intent. Each ATSU selects the EPP elements it requires to improve its own trajectory predictions.

Use Case: Provision of EPP data by C-ATSU

This use case describes the process by which C-ATSU establishes an ADS-C contract with a suitably equipped aircraft in order to request and receive the EPP report, and makes this report available to other stakeholders via the Flight Object.

Before the aircraft enters the C-ATSU's AoR, C-ATSU establishes an ADS-C contract with the aircraft, requesting that the aircraft downlinks EPP information. C-ATSU then updates the Flight Object with the EPP information, making it available to other ATSUs.

Note that the use of datalink is not geographically constrained to an ATSU's AoR, and so further work may be required to establish business rules around when an ATSU will attempt to establish contract.

The Flight Object is also updated with an indication, for each portion of EPP trajectory that crosses a different ATSU's AoR, that the EPP trajectory has not been checked against the ground planning trajectory held in the Flight Object. Note that the discrepancy check is not a prerequisite to updating the FO with EPP data, and is addressed in a separate use case.

Generally, this process will not involve controller teams.

Actors

Aircraft – the aircraft equipped to provide EPP through the ADS-C application.

C-ATSU – an ENR/APP ATSU that has the aircraft in its AOI

D-ATSU an ENR/APP ATSU whose AoR the flight is expected to cross

Preconditions and Assumptions

The aircraft and ATSU are equipped with CPDLC and ADS-C to meet the SC214/WG78 datalink standards.

The aircraft has successfully logged on to the ground system of the ATSU using the DLIC service and both the air and ground indicate that they support the ADS-C application.

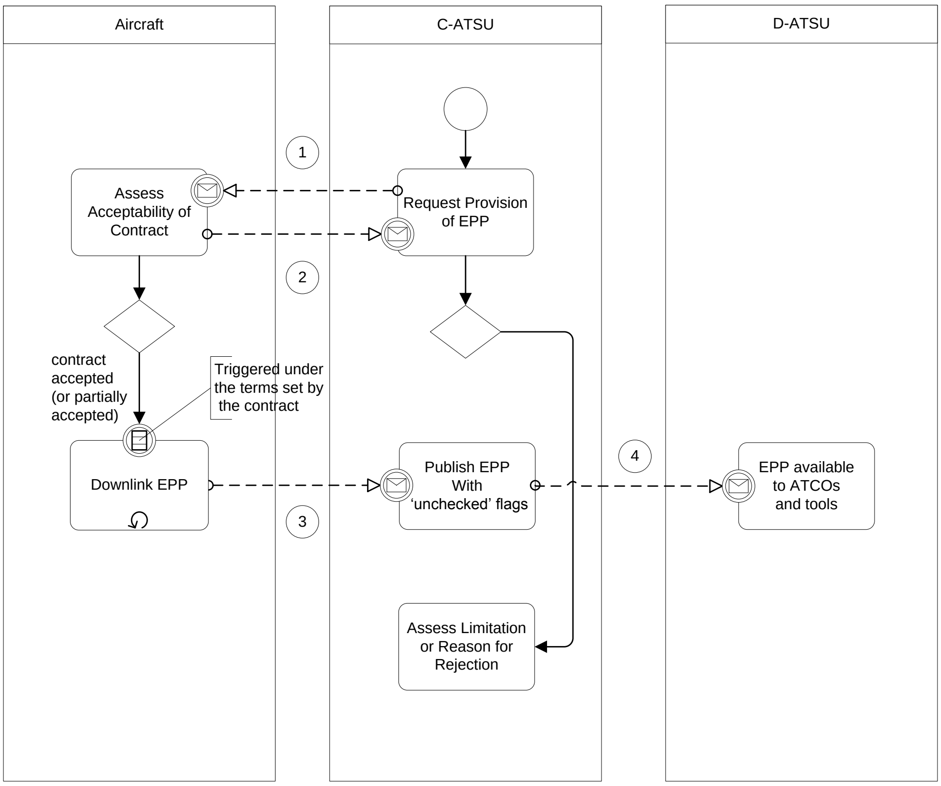
Operational Activity Description

The use case is triggered when C-ATSU determines that the aircraft is at a pre-determined time and/or distance from entering its AOR.

The operating method is described below:

Step	Operating Method
1	At a predetermined time and/or distance from the aircraft entering C-ATSU's area of responsibility, C-ATSU system sends an ADS contract request to the aircraft for EPP data. Note: the ADS contract request will be an on-event contract with TMR thresholds defined (values to be determined from validation) Note: for aircraft departing from an airfield, the contract request may occur prior to departure
2	Upon reception of the ADS contract request, the aircraft determines if it can fulfil the demands of the contract and returns the appropriate ADS contract response.
3a	The contract is accepted (or partially accepted); the aircraft downlinks the baseline EPP in accordance with accepted contract terms
3r	OR The aircraft downlinks a rejection of the contract.
4	If the contract was rejected (or only partially accepted), the ATSU assesses the limitation (if partially accepted) or reject reason to determine if further action is needed. Note – an on-event contract may be partially accepted if the aircraft does not support all of the requested event types and/or there are supported event types for which it cannot supply the required information.
5	C-ATSU system updates the Flight Object with the downlinked EPP data, and 'unchecked' status indication.
6	D-ATSU system retrieves the EPP data, and check status, from the FO
7	D-ATSU tools and ATCOs have access to EPP data

The following Business process Model and Notation model illustrates the trajectory management aspects of the use case. Interactions involving ENR/APP ATC are labelled for subsequent identification of information exchanges.



Operational Activity Model for Establishment of ADS-C Contract

Information Exchanges

The information exchanges to establish the downlink to the EPP are as follows:

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Request EPP downlink	C-ATSU	Aircraft	ADS Event Contract
2	EPP Contract Response	Aircraft	C-ATSU	Choice of: ADS Positive Acknowledgement ADS Non-Compliance Notification ADS Reject Notification
3	Aircraft Downlink of EPP	Aircraft	C-ATSU	ExtendedProjectedProfileReport
4	Provision of EPP	C-ATSU	D-ATSU	ExtendedProjectedProfileReport

Use Case: Provision of EPP data by Third Party ATSU

This use case describes the process by which EPP data is provided when C-ATSU is unable to establish an ADS-C contract with the aircraft.

An ATSU other than the C-ATSU establishes an ADS-C contract with a suitably equipped aircraft in order to request EPP information, and makes this information available to other stakeholders via the Flight Object.

Before the aircraft enters the C-ATSU's AoR, C-ATSU requests the 'provision of EPP' service from a 3rd Party ATSU (3rd-ATSU). This is an ATSU who has declared that they are able to provide the 'provision of EPP data' service. 3rd-ATSU establishes an ADS-C contract with the aircraft, requesting that the aircraft downlinks EPP information. 3rd-ATSU then updates the Flight Object with the EPP information, making it available to other ATSUs.

The Flight Object is also updated with an indication, for each portion of EPP trajectory that crosses a different ATSU's AoR, that the EPP trajectory has not been checked against the ground planning trajectory held in the Flight Object. Note that the discrepancy check is not a prerequisite to updating the FO with EPP data, and is addressed in a separate use case.

Note also that 3rd-ATSU can be any other ATSU who is capable of establishing an ADS-C contract with the aircraft in its present location, and receiving EPP data. This may be a previous C-ATSU, a D-ATSU, or a nearby ATSU who is not planned to work the flight.

Generally, this process will not involve controller teams.

Actors

Aircraft – the aircraft equipped to provide EPP through the ADS-C application.

C-ATSU – an ENR/APP ATSU that has the aircraft in its AOI

D-ATSU an ENR/APP ATSU whose AoR the flight is expected to cross

3rd-ATSU – an ATSU who is equipped to receive and publish EPP information.

Preconditions and Assumptions

The aircraft and 3rd-ATSU are equipped with CPDLC and ADS-C to meet the SC214/WG78 datalink standards.

The aircraft has successfully logged on to the ground system of the 3rd-ATSU using the DLIC service and both the air and ground indicate that they support the ADS-C application.

Operational Activity Description

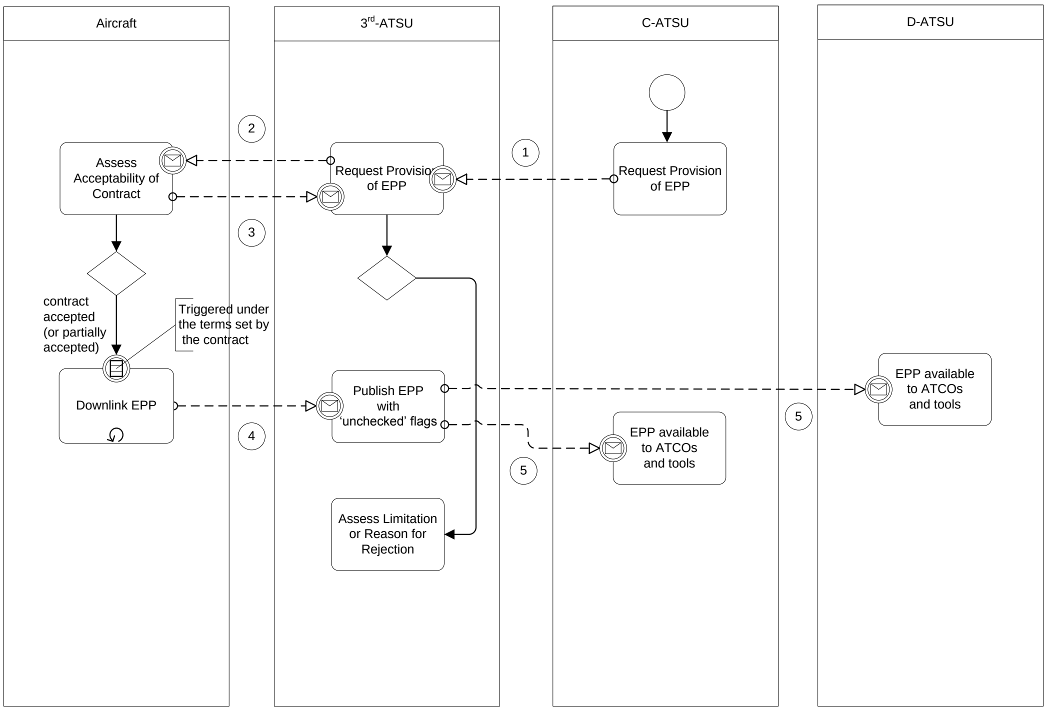
The use case is triggered when C-ATSU determines that the aircraft is at a pre-determined time and/or distance from entering its AOR.

The operating method is described below:

Step	Operating Method
1	At a predetermined time and/or distance from the aircraft entering C-ATSU's area of responsibility, C-ATSU system requests the provision of the aircraft's EPP data from 3rd-ATSU.
2	3rd-ATSU sends an ADS contract request to the aircraft for EPP data. Note: the ADS contract request will be an on-event contract with TMR thresholds defined (values to be determined from validation) Note: for aircraft departing from an airfield, the contract request may occur prior to departure

3	Upon reception of the ADS contract request, the aircraft determines if it can fulfil the demands of the contract, and returns the appropriate ADS contract response.
4a	The contract is accepted (or partially accepted); the aircraft downlinks the baseline EPP in accordance with accepted contract terms
4r	OR The aircraft downlinks a rejection of the contract.
5	If the contract was rejected (or only partially accepted), the 3rd-ATSU assesses the limitation (if partially accepted) or reject reason to determine if further action is needed. Note – an on-event contract may be partially accepted if the aircraft does not support all of the requested event types and/or there are supported event types for which it cannot supply the required information.
6	3rd-ATSU system updates the Flight Object with the downlinked EPP data, and 'unchecked' status indication.
7	C-ATSU and D-ATSU system retrieves the EPP data, and check status, from the FO
8	C-ATSU and D-ATSU tools and ATCOs have access to EPP data

The following Business process Model and Notation model illustrates the trajectory management aspects of the use case. Interactions involving ENR/APP ATC are labelled for subsequent identification of information exchanges.



Information Exchanges

The information exchanges to establish the downlink to the EPP are as follows:

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	ATSU Request for EPP	C-ATSU	3rd-ATSU	Request for EPP
2	Request EPP downlink	3rd-ATSU	Aircraft	ADS Event Contract
3	EPP Contract Response	Aircraft	3rd-ATSU	Choice of: ADS Positive Acknowledgement ADS Non-Compliance Notification ADS Reject Notification
4	Aircraft Downlink of EPP	Aircraft	3rd-ATSU	ExtendedProjectedProfileReport
5	Provision of EPP	3rd-ATSU	C-ATSU & D-ATSU	ExtendedProjectedProfileReport

Use Case: C-ATSU Performs Consistency Check

This use case describes the process by which the ground checks the consistency of the flight information held in the EPP against that held by the ground. References to other use cases that describe how discrepancies are resolved are made in the operating method where appropriate.

Following the update of EPP data held in the Flight Object, an ATSU, who is capable of performing the consistency check, retrieves both the EPP data and the ground planning trajectory from the FO. The ATSU performs a 2D check of the received EPP against the ground planning trajectory for the IOP area. The check compares published waypoints, and/or latitude/longitude of agreed points in the case of free-route trajectories.

The 2 trajectories will be considered consistent if the waypoints in the trajectory match and are in the same sequence. In the case of waypoints defined as latitude/longitude, the trajectories are considered to be consistent if the points align within a predefined distance, to be determined

Should an inconsistency be found for a portion of the trajectory crossing an ATSU AoR, the ATSU performing the check will update the FO with a consistency check set to 'not ok' for that ATSU. Further downstream ATSUs are then set to 'not checked'. Where the ground and air routes do align across an AoR, the FO is updated with a consistency check set to 'ok'.

Note that the checking of the EPP is not a prerequisite to its publication in the FO. However, if C-ATSU both receives the downlink of the EPP and performs the consistency check, they may perform the check before publishing the EPP data to the FO.

Generally this process will not involve the controller teams.

Typically the check will be performed by C-ATSU; however if they are unable to, then the checking service may be provided by another agency (e.g. D-ATSU or 3rd-ATSU). For the presentation of this use case, it is assumed that the checking service is performed by C-ATSU.

Actors

C-ATSU– the ATSU that performs the consistency check

D-ATSU – an ATSU whose AOR will be crossed by the flight.

Preconditions and Assumptions

EPP data has been downlinked from the flight.

C-ATSU is able to unambiguously associate the downlinked EPP to the correct flight object, and the consistency check status information to the correct EPP.

The ATSUs have agreed to support i4D operations (e.g. through LOA) which includes the checking of intent information between the air and ground trajectory along with the publication of current consistency status. Additionally, they have agreed the minimum requirements for the ADS-C contract for the EPP (in terms of EPP information content and TMRs).

The EPP information downlinked is that defined through the SC214/WG78 datalink standards.

The Flight Object is accessible to C- ATSU as the aircraft is within its AOR.

The Flight Object is accessible to D- ATSU as the aircraft is planned to enter its AOR.

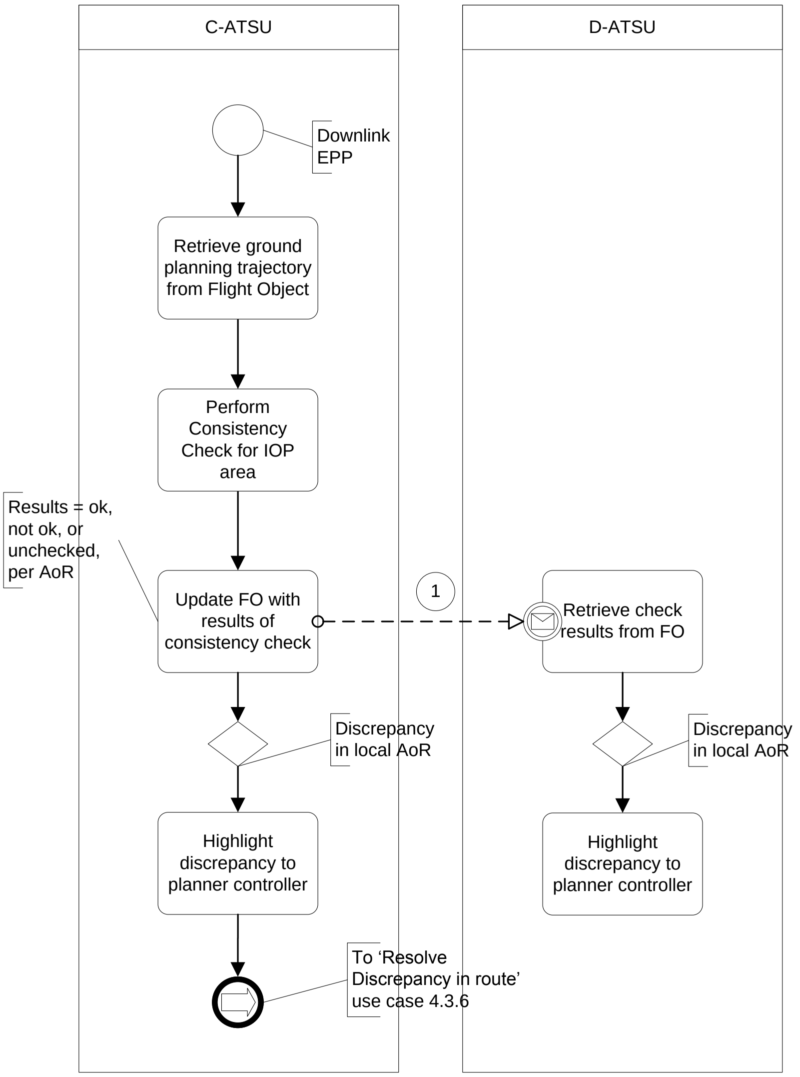
Operational Activity Description

The use case is triggered when the aircraft downlinks an EPP report to C-ATSU.

The operating method is described below:

Step	Operating Method
1	C-ATSU system retrieves the ground planning trajectory from the FO.
2	C-ATSU systems performs consistency 2D check of the EPP route with the ground planning trajectory
3	The C-ATSU system updates the Flight Object with the results of the consistency check for each AoR that is planned to be crossed.
4	D-ATSU system retrieves the latest EPP information, along with consistency status information that is of interest to it, from the Flight Object. The consistency status information is used, if required, to determine the potential validity of using the EPP information or performing some i4D operations within the AOR (e.g. suitability of EPP ETAs for AMAN, validity of requesting the reliable ETA min/max or agreeing a CTA with the flight crew, etc.). NOTE: Downstream ATSUs would be interested in the consistency status of those ATSUs which lie upstream.
5	If there is a 2D route discrepancy in an ATSU's AoR, an indication is provided on the HMI to warn the planner controller where there is a discrepancy between the air and ground route within their AOR.

The following Business process Model and Notation model illustrates the trajectory management aspects of the use case. Interactions involving ENR/APP ATC are labelled for subsequent identification of information exchanges.



Operational Activity Model for Perform Consistency Check

Information Exchanges

The information exchanges for the EPP consistency check use case are as follows:

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Provide EPP Consistency Status to Flight Object	C-ATSU	D-ATSU	EPP Consistency Status for each AoR to be crossed [unchecked, ok, not ok] NOTE: this is expected to be simple flag or status, to indicate if the flight intent held by the ground and air are consistent, inconsistent, or not checked.

Use Case: Resolve Discrepancy in Route

This use case describes the process by which the route in the air and ground trajectories are synchronised if the controller has been warned of a route discrepancy.

Note that this use case is written from the perspective that assumes any discrepancy between the route in the EPP and ground held trajectory will be uncommon. Differences in the routing held between the air and ground are rare even in today's operation. Therefore, this use case describes a simple operational procedure whereby the ATSU in which a discrepancy is detected will be responsible for resolving it. Further work will be required if more complex and automated solutions are considered operationally desirable, e.g. earlier resolution of discrepancies, the role of ground automation in uplinks, etc.

Actors

Aircraft – the aircraft equipped to accept route clearances through CPDLC and provide EPP through the ADS-C application

C-ATSU – an ATSU that is currently controlling the aircraft.

Preconditions and Assumptions

The current controlling ATSU has successfully established an ADS-C contract with the aircraft for the provision of the EPP and is logged on to the aircraft for CPDLC services.

The flight is under control of the ATSU in which the discrepancy originates.

Operational Activity Description

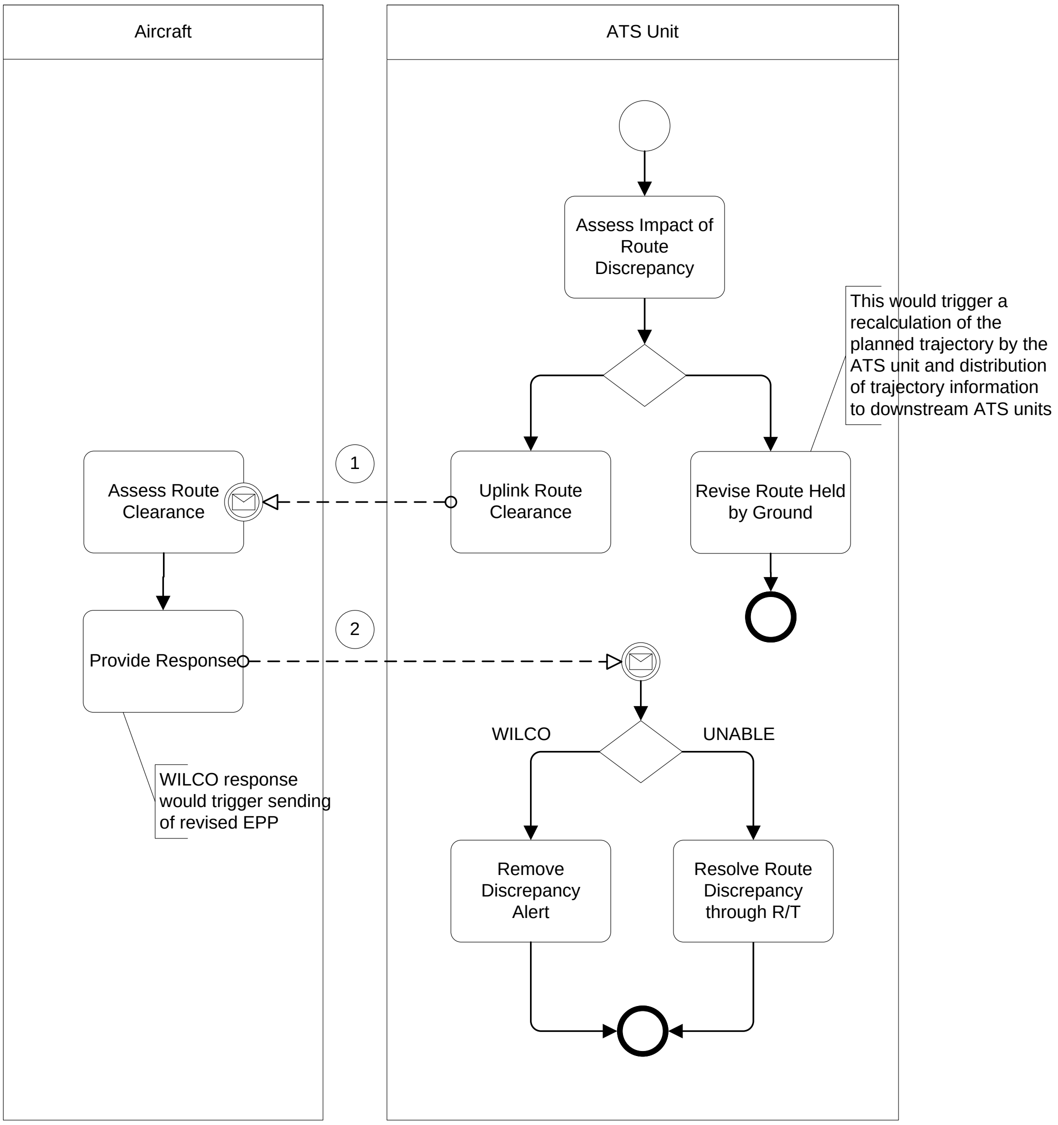
The use case is triggered when the ground system of the ATSU displays a route discrepancy warning to the controller.

The operating method is described below:

Step	Operating Method
1	The controller is warned of the route discrepancy and uses the HMI to assess the impact of the difference in the route data. Depending upon the impact (e.g. their sector only, limited to the AOR of the ATSU, or impact external to the ATSU), the controller may need to coordinate the plan to resolve the discrepancy. NOTE: If coordination is required, this use case assumes that it is conducted through voice communications.
2	If the controller decides to accept the route from the aircraft trajectory, then the controller revises the route held by the ground system to match that held by the aircraft. The 2D discrepancy warning is removed from the HMI. The use case ends. Note – the route is revised in the Flight Object, thereby making it available to downstream ATSUs
3	If the controller decides to revise the route held by the aircraft, then the controller uses the HMI to uplink the appropriate Route Clearance message based on the existing ground route or constructs a new one. NOTE: The system is expected to support the controller in auto-generating the appropriate uplink message based on the existing ground held route. This uplink should also contain appropriate level constraints from the ground trajectory. NOTE: the revise rouite clearance may be provided to the aircraft via voice communications.

4	The flight crew are alerted to the incoming ATC communication and the message is displayed to them. They assess the impact of the change in the Route Clearance and if acceptable WILCO the message, and executethe instruction in the FMS. If the change is not acceptable the flight crew UNABLE the message with the reason for the rejection. NOTE: As a result of accepting the change a new EPP is downlinked.
5	The controller is made aware through the HMI of the flight crew response to the uplinked Route Clearance. If WILCO was received from the flight crew, the 2D discrepancy warning is removed from the HMI. If UNABLE was received from the flight crew, the controller reverts to voice communication to resolve the problem.

The following Business process Model and Notation model illustrates the trajectory management aspects of the use case. Interactions involving ENR/APP ATC are labelled for subsequent identification of information exchanges.



Information Exchanges

The information exchanges for the resolution of a route discrepancy use case are as follows:

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Uplink Route Clearance	ATSU	Aircraft	Route Clearance (this may include level constraints depending on local operating procedures)
2	Route Clearance Response	Aircraft	ATSU	Pilot Confirmation (WILCO/UNABLE)

Use Case: Provide Level Constraints

Arrival management concepts that make use of a time constraint to sequence or meter traffic at a waypoint in the descent profile will require that the level constraints are synchronised between the air and ground trajectories. This use case describes the process by which a controller performs the level constraint synchronisation as part of agreed arrival management procedures.

Note that the level constraints are assumed to already exist in the Flight Object. The revision of the flight object to insert such constraints is not part of this use case.

According to ATC procedures, aircraft will not make vertical manoeuvres without a specific clearance either via voice or datalink[18]. However, the HMI may be adapted to indicate to the controller that a level constraint discrepancy exists between the aircraft and the ground , particularly at specific en-route sectors where inbound aircraft enter the arrival management planning horizon of the destination airport.

Actors

Aircraft – the aircraft equipped to provide EPP through the ADS-C application

C-ATSU– an ATSU that is currently controlling the aircraft.

Preconditions and Assumptions

C-ATSU has successfully established an ADS-C contract with the aircraft for the provision of the EPP and is connected with the aircraft for CPDLC services.

The aircraft is in cruise phase, with sufficient time prior to Top of Descent to allow the re-planning of the descent profile if provided with new constraints.

The 2D routes are consistent between the air and ground trajectories.

The flight is under control of the sector in which the controller is operating.

Operational Activity Description

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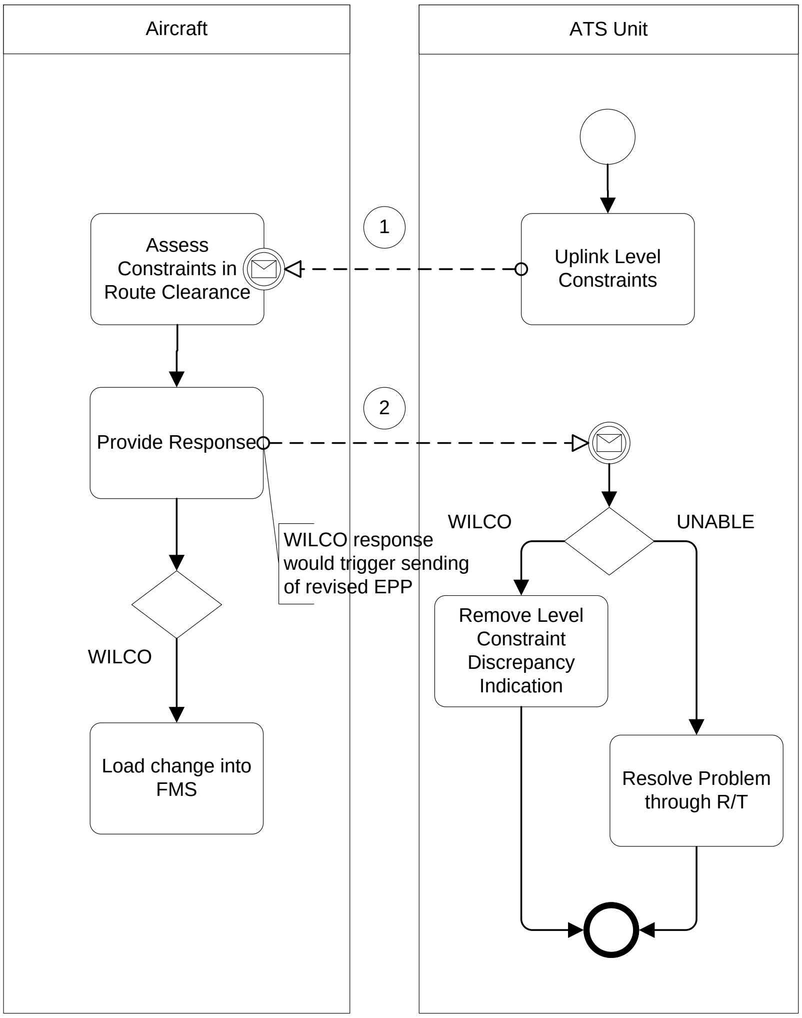
[18] An aircraft may deviate from its vertical clearance in response to an ACAS Resolution Advisory; the ATC response to such manoeuvres is governed by specific procedures and is not covered in this use case.

The operating method is described below:

Step	Operating Method
1	The HMI indicates to the controller that the EPP is not synchronised with the ground held level constraints required by the arrival management procedure for the destination airport of the aircraft. ALTERNATIVE As part of agreed arrival management procedures that impact the en-route sector, the controller uses the HMI to check that the EPP contains the level constraints as required by the arrival management procedure for the destination airport. If the EPP contains the level constraints as required by the arrival management procedure then the use case ends.
2	The controller uses the HMI to generate and uplink the appropriate trajectory clearance message containing the required level constraints defined on the appropriate waypoints. NOTE: The vertical profile expressed through the level constraints in the Route Clearance is for trajectory calculation only. No vertical manoeuvre may take place without explicit clearance from the controller, either by voice or by datalink. NOTE: The system is expected to support the controller in auto-generating the appropriate uplink message to provide the ground held level constraints to the aircraft. NOTE: the revised route clearance may be provided via voice communications.
3	The flight crew are alerted to the incoming ATC communication and the message is displayed to them. They assess the impact of the change in the Route Clearance and if acceptable WILCO the message. If the change is not acceptable the flight crew UNABLE the message. NOTE: As a result of accepting the change a new EPP is downlinked.
4	The controller is made aware through the HMI of the flight crew response to the uplinked Route Clearance. Any indication of a level constraint uplink task is removed from the HMI. If UNABLE was received from the flight crew, the controller reverts to voice communication to resolve the problem.

The following Business process Model and Notation model illustrates the trajectory management aspects of the use case. Interactions involving ENR/APP ATC are labelled for subsequent identification of information exchanges.



Operational Activity Model to Provide Level Constraints

Information Exchanges

The information exchanges for the provision of level constraints use case are as follows:

No.	Information Exchange Name	Issuer	Addressees	Information Element(s)
1	Uplink Level Constraints	ATSU	Aircraft	Route Clearance (Level constraints are included at the appropriate route points in the clearance)
2	Route Clearance Response	Aircraft	ATSU	Pilot Confirmation (WILCO/UNABLE)

Use Case: Ground Trajectory Prediction Improvement using the Extended Projected Profile

This nominal use case for SESAR step 1 describes the use of downlinked EPP data sent by the aircraft system to improve ground trajectory prediction within ATSUs..

It was considered out of scope to provide a detailed description on how ATSUs may use the improved ground TP outputs in various client applications (e.g. an improved planned trajectory can be consumed by local NM for DCB purposes, arrival management, etc.).

Actors

Aircraft - (FMS, ADS-C) downlinks the requested EPP data.

C-ATSU- is the ATSU currently responsible for the control of the aircraft. It has an ADS-C contract with the aircraft, triggering EPP data downlink from the Aircraft FMS. This data is required to improve its ground trajectory prediction.

D-ATSUs - are the ATSU(s) responsible for control of an airspace region through or near which the aircraft will progress at some future time – this may include also adjacent units to C-ATSU. They require EPP data distribution from the C-ATSU to improve their ground trajectory predictions.

Preconditions & Assumptions

This use case assumes the C-ATSU to have an ADS-C contract with the aircraft. It does not consider the usage of additional contracts made by D-ATSUs.

The C-ATSU ADS-C contract specifies :

- The EPP downlink trigger, which may be
    a) On event, e.g. using Trajectory Management Requirements (TMRs),
    b) Periodically with the associated periodicity
    c) On demand
- The list of requested EPP information for ground trajectory prediction improvement
    - This list can encompass the integral list of all the possible EPP data or the minimum mandatory one.
    - The choice depends on what is required for ground TP improvement (for this use case), current conditions (e.g. bad weather) technical feasibility: e.g. in a first step, this data could be limited to mass and speed schedule, later steps could introduce the use of the EPP 4D profile.
    - It gives an indicative list of data items. As an example, the number of EPP points in the contract can be selected up to 128 (using less reduces the message size, but will be of a more limited usage by the D-ATSUs).
    - Detailed list of EPP information and contract types are defined through the SC214/WG78 data link standards.

All the ATSUs are assumed to be in IOP area: this allows the requested EPP data from C-ATSU to be shared among all the concerned ATSUs, allowing D-ATSUs to improve their ground trajectory predictions using this data.

This implies that the C-ATSU ADS-C contract covers also the needs of the D-ATSUs, both in terms of EPP data and required level of accuracy (e.g. frequent EPP updates or not).

Some level of agreement among the ATSUs is assumed, including for example, the minimum update frequency for periodic updates or the trajectory management requirements (TMRs) settings for EPP on event contracts. Impact of standardisation shall be assessed as current standards WG78 evolved from their previous version H, to the newer version M, in which EPP Tolerance Event can be associated only with one given waypoint instead of multiple ones. Note that ED-228 is now available.

The information in the EPP report is considered of sufficient quality to be used for ground trajectory prediction improvement.

C-ATSU and D-ATSU(s) are capable of processing EPP information (check for discrepancies in 2D and 3D perspective, display and use for ground TP improvement).

The Flight Object is accessible to the current controlling and downstream ATS unit(s).

Note: in some cases it is better not to update the TP with the EPP - e.g. for long directs where no MET info is available in the FMS or in case the initial flight intent is changed (e.g. during open loop vectoring). It should not be taken for granted that the EPP will be used to improve the ground TP.

Note: The scope/distance (e.g. over C-ATSU AoR / AoI or for the all Downstream units) of the ground TP computations improved by EPP and incorporated in the Flight Object is subject to further validation.

Post-conditions

Success end state

Following the air-ground (and ground-ground) EPP sharing, among all concerned ATSUs, the ground TP lateral, longitudinal, vertical and temporal accuracies have been improved within pre-defined values, ready for use in specific operational related applications.

Failed end state

i. Local ground trajectory of the controlling ATSU has not been synchronized with the predicted trajectory down-linked via the Aircraft EPP report.

Note: the case when the EPP is not of sufficient quality to be used is considered to be a failure case, since the goal of the use case is to describe a ‘nominal’ (and very likely) situation when EPP data may improve the ground system.

ii. The ground TP output does not reach the expected performance level in lateral, longitudinal or temporal, required for the targeted operational related application.

Operational Activity Description

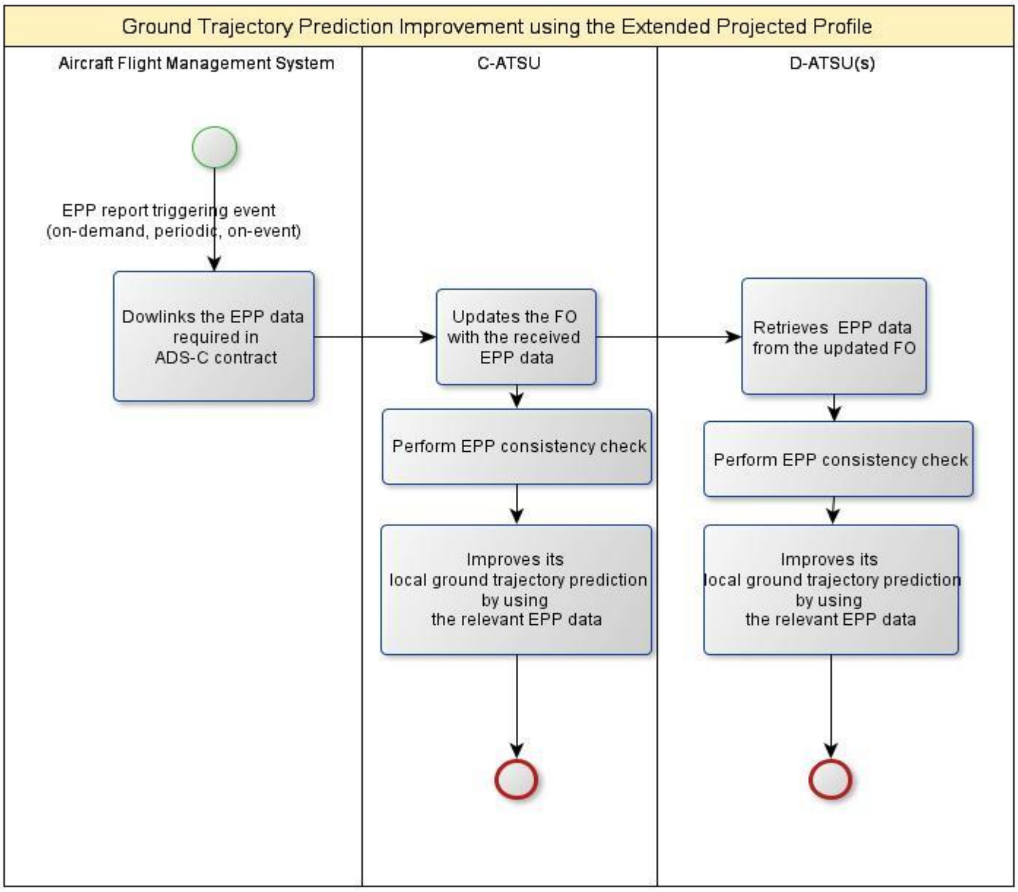
The use case is triggered when the aircraft FMS sends an EPP report to C-ATSU, in accordance with the ADS-C contract terms specified by C-ATSU.

The operating method is described below:

Step	Operating Method
1	The Aircraft Flight Management System downlinks the latest EPP data required to the C-ATSU according to the terms set in the ADS-C contract between the two actors.
2	The C-ATSU automatically updates the Flight Object with the received EPP information
3	The D-ATSUs retrieve the EPP information from the updated Flight Object.
4	Each ATSU (C-ATSU, D-ATSUs) checks the EPP report for discrepancies (coherence and consistency) within its area of responsibility (AOR) (see Use Case “Consistency Check of Flight Intent”) and updates the Flight Object with the EPP consistency status for its AOR. Note: this nominal case assumes a successful check.

5	Each concerned ATSU uses relevant EPP information to improve the quality of its ground trajectory prediction. As a result, the lateral, longitudinal, vertical and temporal ground TP errors shall not exceed, after synchronisation, minimum predefined values in order to be used for operational purposes. Note : The C-ATSU improved ground trajectory prediction may also be made available to the concerned D-ATSU (subject to validation).

The following Business process Model and Notation model illustrates the information exchanges associated to this use case.



Essential prerequisites

The data link capability as described in Commission Regulation (EC) No 29/2009.

Deliverables

- Demonstration Plan
- Availability Note

- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Extended Arrival Management (AMAN) horizon
- MET Information Exchange
- SESAR 2020 Solutions PJ10-02 A & B (cooperation required)

Potential cooperation opportunities with other Demonstration projects

- Arrival Management extended to en-route Airspace
- Network Collaborative Management
- Flight Information Exchange

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are “certified” against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this “early” SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner (prior to the execution of demonstration exercises) as it may result in additional

design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.

- Applicable Requirements for Airborne part:
    - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.

D.7 Enabling Aviation Infrastructure – Flight Information Exchange (PJ27)

Title: PJ27 - Flight Information Exchange

Demonstration overview

This VLD project covers flight information exchange during the pre-tactical and tactical phases by ATC systems and Network Manager within Europe.

This VLD is an integral part of the SESAR Solutions delivery approach towards the SESAR deployment phase. The objective of this VLD is to bridge "industrial research" and "deployment" related to the PCP ATM Functionality 5 (as defined in Commission Implementing Regulation EU No 716/2014), and not to replace either type of activity.

Once awarded this VLD shall establish a limited set of connected SESAR high-technology demonstration platforms in relation to the "Enabling Aviation Infrastructure" key feature of the SESAR 2020 programme.

The main objective of this VLD during Wave 1 is to ensure that FO-IOP works in the real world upper En-Route airspace 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 key deployment aspect, because FO-IOP and OLDI are expected to co-exist in operational service for a very long transition period.

The functional and geographical scope of this VLD are to demonstrate that FO-IOP works in upper airspace ACCs, supporting standard coordination and transfer functions during execution flight phase, based on SESAR1 P10.02.05 Technical Specification D55.

Operational Use Cases to be covered here can be summarised as follows:

- Nominal Conditions:
    1. Flights Coordination with Flight Object and OLDI in parallel;
    2. Transfer of Flights;
    3. Information Distribution between ATSUs;
    4. Direct Routings;
- Non Nominal Conditions:
    1. Flight Object Fallback Situations
    2. Flight Object Error Handling

This demonstration will address only G/G Interoperability between ATC.

The VLD shall use "Shadow Mode" and "Live Trials" techniques:

- Shadow Mode shall demonstrate 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. The added value of the shadow mode is to allow performing real time validation operating in the real operational traffic scenarios.
- Live Trial shall be executed in a real operational environment with a direct impact on air

traffic. Hence it is necessary to include all safety and security related activities, to assure there will be no adverse impact on, or risk introduced to air traffic.

The following activities shall be performed:

- Shadow Mode in upper airspace.
- Preparation of Live Trials in upper airspace.
- Completion of Live Trials in upper airspace.

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

- Integration of a Flight Object component.
- Integration of blue-profile SWIM services to exchange flight object information.
- Integration of common and synchronised Meteorological data, static AIM data (AIRAC), dynamic AIM data, Airspace Configuration data and Aircraft performance data via yellow-profile SWIM services.
- Provision of the necessary SWIM infrastructure.

This demonstration will assess the benefit of Flight Information Exchange to improve ATM Network performance; it will serve as Proof of Concept for this sub-functionality of AF#5 as defined in the PCP.

Platform development requirements

The demonstration shall be set up using:

- The Network Manager platform at the level of pre-operational or operational status to support the Proof of Concept.
- At least 3 ATS platforms at the level of pre-operational or operational status to support the Proof of Concept.

All VLD platforms shall be sufficiently integrated and use common specification in accordance with P 10.02.05 D55, 14.01.04 D43-004/005 and 14.01.03 D37.

The demonstration platform(s) to be developed and established shall be consistent with the system requirements outlined in the PCP regulation for the targeted ATM functionality. By regulation these are:

- ATC systems shall make use of the following flight information exchange services:
    - using the blue SWIM TI Profile:
        - Various operations on a flight object: Acknowledge reception, Acknowledge agreement to FO, End subscription of a FO distribution, Subscribe to FO distribution, Modify FO constraints, Modify route, Set arrival runway, Update coordination related information, Modify SSR code, Set STAR, Skip ATSU in coordination dialogue
        - Share Flight Object information. Flight Object includes the flight script composed of the ATC constraints and the 4D trajectory
    - Using the yellow SWIM TI Profile:
        - Validate flight plan and routes
        - Flight plans, 4D trajectory, flight performance data, flight status
        - Flights lists and detailed flight data

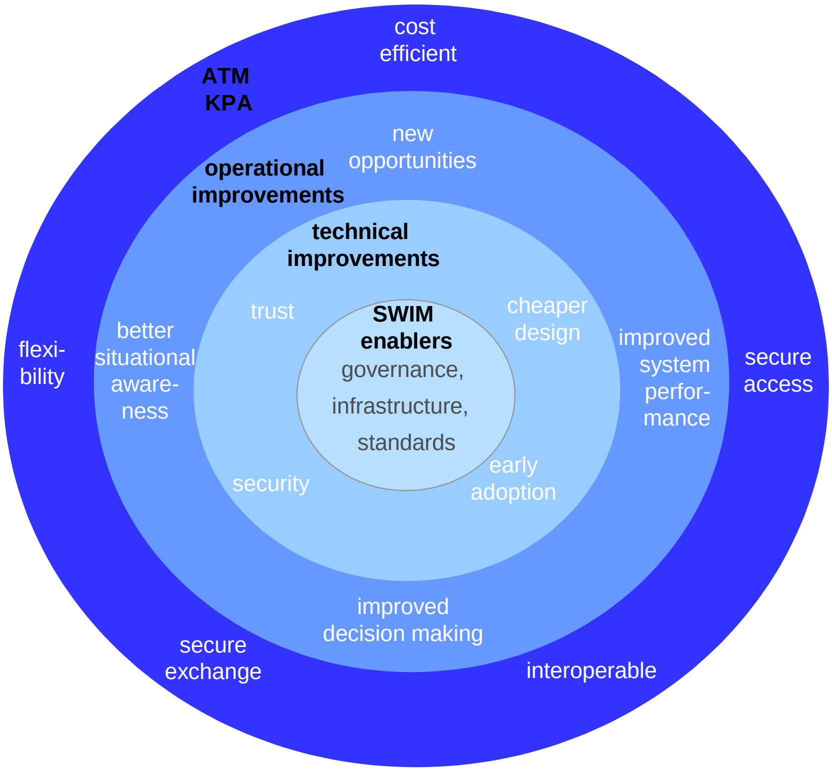
    - Flight update message related (departure information)
  - Service implementations shall be compliant with the applicable version of AIRM, the AIRM Foundation Material and the ISRM Foundation Material.

Contextual Information

SWIM and the future ATM system

The European air traffic management system is operating close to its limits and is facing the challenge of continuously growing demand in air transport. In order to meet all of the goals set by the EC and strengthen the air transport value chain, the airspace users' requirements need to be better accommodated. To this end, each single flight must be executed as closely in line with the intentions of its owner as possible, while at the same time the network performance is maximised. This is the main driving principle for the future ATM system, which is centred on the characteristic of the business trajectory (known in the military as the "mission trajectory") representing an airspace user's intention with respect to a given flight.

SWIM is an important foundation and enabler to the overall future ATM Concept of Operations. It will introduce a complete change in how information is managed throughout its life cycle across the whole European ATM system. SWIM is a key enabler for the future SESAR system, and as such SWIM enables direct ATM benefits from business, operational and technical points of view as represented in the following figure.



As depicted in the figure, SWIM will enable technical improvements like cheaper design, early (or easier) adoption, etc. These technical improvements will in their turn enable operational improvements like better situational awareness. The operational improvements will contribute to the ATM Key Performance Areas (KPA) identified in the SESAR Programme.

SWIM enables better financial performance and unlocks new opportunities. By using mainstream technologies, open formats and standardised interfaces, it is expected to reduce the costs associated with the development and deployment of new applications and services. The service standardisation will facilitate the reuse of information in other contexts thereby contributing to cost efficiency. The increased interoperability of data formats and interfaces will make possible a LEGO-like system architecture, in which ATM systems from different manufacturers can be seamlessly connected, eliminating the need for expensive tailor-made interfaces.

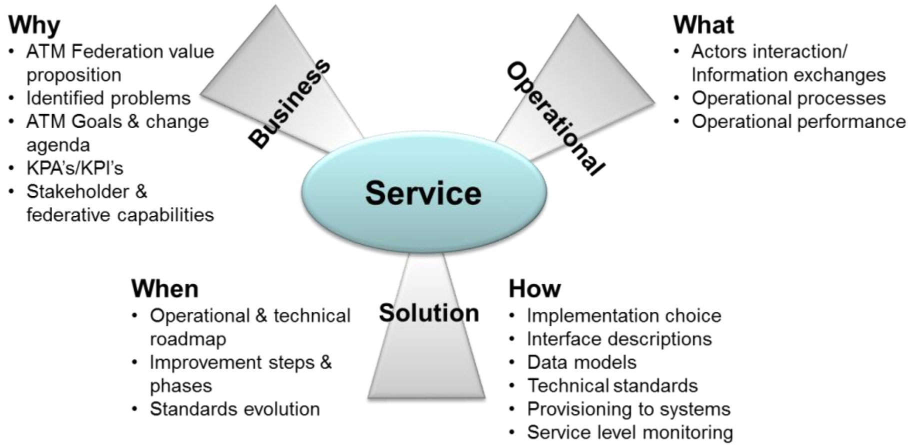
SWIM in practice

In order to build SWIM (i.e. SWIM in practice) the following elements are needed:

- an ATM information model representing the standard definition of all ATM information, through harmonised conceptual and logical data models. In the context of the SESAR Programme, this is instantiated in the AIRM (ATM Information Reference Model);
- an ATM services model representing the logical breakdown of required information services and their behavioural patterns. These services are also called ATM-specific services. In the context of the SESAR Programme, this is instantiated in the ISRM (Information Service Reference Model);
- information management functions (including governance), such as user identity management, discoverability of resources, security aspects such as authentication, encryption and authorisation, notification services and registration need to be defined to support information sharing. SWIM governance affects almost all of the roles and their interactions within the ATM system;
- the SWIM technical infrastructure (SWIM-TI) is the interoperable (runtime) infrastructure (ground/ground and air/ground) via which ATM data and services are distributed, shared and consumed. Its implementation may, depending on the specific needs profile, differ from one stakeholder to another, in terms of both the scope and the type of implementation. It will mostly be based on commercial off-the-shelf (COTS) standards-based and interoperable products and services, but it is possible that in some cases specific software may need to be developed;
- SWIM-enabled applications: the implementation of SWIM in the ATM system enables ATM business benefits by assuring the provision of commonly understood quality information to the right people at the right time.

SWIM is built based on a number of principles driving its definition and construction. One of the key principles is the service orientation approach, which aims to use the service concept to describe ATM information exchanges among ATM systems in the ATM enterprise. In this context, a service can be described using various perspectives or aspects:

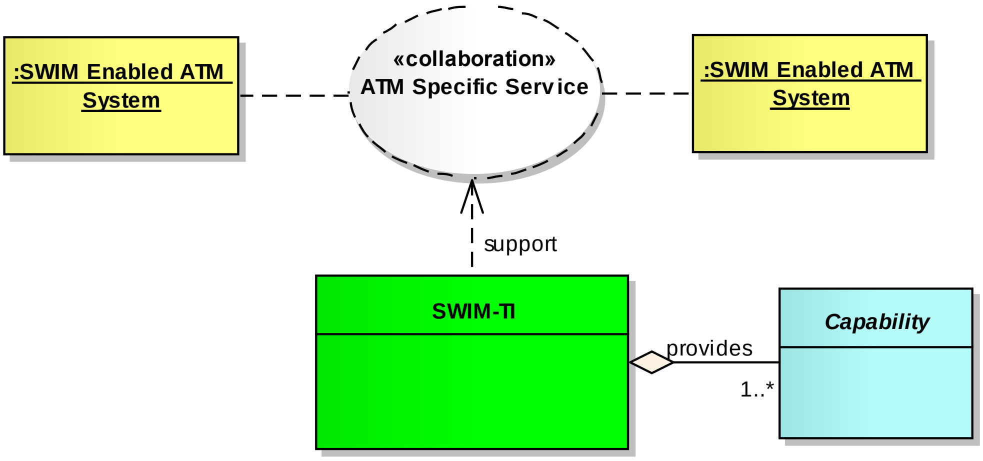
- The business aspect of a service generally addresses the reasons for the service and is therefore related to its goals and value proposition. The business aspect can also address the business and legal entities which provide and use the service, i.e. the ATM stakeholders.
- The operational aspect of a service describes what the service is about, and how it relates to operational processes in European ATM and the surrounding environment. This description acts as input for determining how the service is to be implemented.
- The solution aspect of a service defines how it is provided within European ATM. This includes a determination of whether the service is provided using technological automation or human resources only.
- The time perspective is of course also important so that there can be agreement on when the various services will be in place.



Service aspects

The SWIM-TI contributes to the services' solution aspects providing means supporting effective and secure ATM-specific service provision and consumption among SWIM-enabled ATM systems.

SWIM-enabled ATM systems collaborate using an ATM-specific service, and this collaboration is supported by technical capabilities offered by the SWIM-TI.



SWIM-TI and ATM system collaboration

Taking into account all of the ATM systems and data domains, and the various flight phases (planning, execution and post-execution), it becomes apparent that there will be different ATM-specific services with different requirements (functional and non-functional). The SWIM-TI will be built by specific technical elements identified and implemented in accordance with the needs of each ATM system and service. These technical elements consist of functionalities which are then specified, providing proper architectural items, interfacing layers and standard technologies. The set of functionalities provided by the SWIM-TI represents its functional view and is introduced in the next section.

SWIM-TI functional view

The SWIM-TI is designed and developed taking into account (i) ATM-specific service requirements, and (ii) SWIM-related requirements (e.g. integration requirements needed in order to allow interoperable SWIM integration of such ATM systems).

These requirements, constraints and other relevant design principles are used to identify what the SWIM-TI provides in order to improve common situational awareness delivering the right information to the right people at the right time. This represents the functional view of the SWIM-TI and consists of a set of capabilities (or functionalities or infrastructure services or enabling services).

Examples of enabling services which the SWIM-TI can offer to ATM systems, fitting their needs and ATM-specific service requirements, are the following:

- messaging, which provides decoupled, interoperable and effective communication between information producers and information consumers. This supports different message exchange patterns (e.g. publish-subscribe, request-response, push, etc.), different subscription styles (e.g. durable, non-durable) and different sets of QoS (e.g. best-effort and reliable delivery);
- information discovery, allowing the discovery of relevant information;
- interface management, which makes it possible to manage several kinds of ATM-specific service metadata, allowing this information to be discovered, subscribed and published/updated;
- monitoring and control (supervision), which allows the monitoring and control of other SWIM-TI capabilities. This includes performance monitoring, SLA monitoring, alarm generation, statistics generation, etc.;
- security services, including confidentiality, integrity, availability, access control, accountability and non-repudiation, allowing data exchanged through the SWIM-TI to be protected;
- data validation and transformation, allowing the validation (e.g. against a specific schema) and transformation (e.g. to/from different data representations according to specific policies and rules) of such data exchanged through the SWIM-TI.

A SWIM TI profile defines therefore how the logical information can be described in various technical formats, information can be exchanged using various technical protocols and systems can be connected using different IP networks. The following Ground/Ground profiles have been identified so far in SESAR 1 :

- Blue SWIM TI Profile: This profile shall be used for Flight Object ATC2ATC and ATC2ATFCM data exchange. Keywords are secured access, high response rates and more generally the required SWIM infrastructure Quality of Service (QoS) supporting the deployment of the Flight Object services used in particular in the tactical phase of the flights.
- Yellow SWIM TI profile: This profile shall be used for any other ATM data (aeronautical, meteorological, airport etc.). Keywords are low-threshold-access-(through still secure)-solutions, affordability and rapid pick-up.

Essential prerequisites

ATS platforms shall be connected to the Pan-European Network Services (PENS).

Deliverables

- Demonstration Plan
- Availability Note
- Demonstration Report

Dependencies

Dependencies with SESAR Solutions

- Automated Assistance to Controller for Seamless coordination, transfer and dialogue through improved trajectory data sharing.
- Initial SWIM

Potential cooperation opportunities with other Demonstration projects

- Arrival Management extended to en-route Airspace
- Flexible Airspace Management and Free Route
- Network Collaborative Management
- Initial Trajectory Information Sharing

Programme Execution Framework

The project shall operate under the principles as outlined in the SESAR Programme Execution Guidance edition 1.0 (included in the SESAR 2020 Call for Proposals set of input documents).

It describes the Programme and project management principles together with the roles and responsibilities enabling the development and delivery of the SESAR Solutions according to the ATM Master Plan.

Proof of Concept

The Proof of Concept to be conducted under this VLD is a confidence building exercise that comes in addition to the traditional validation required prior to certification and implementation of new concepts or new technologies.

The Proof of Concept has to be distinguished from operational live trials since it brings a new dimension of the validation: early operations with a significant scale environment.

The proof of concept consists in an early operation of the SESAR Solutions making use of pre-operational or operational products (airborne and ground) in a real operational environment.

To this end, the use of pre-operational products can be envisaged, opening the door for tailored design solutions and tailored certification processes to support the demonstration. But in all cases, full compliance against relevant regulation has to be shown. A revenue flight with pre-operational airborne and/or ground products means that these products are "certified" against the applicable regulations.

- Applicable Requirements for Ground part:
    - The stakeholders participating to VLD shall demonstrate to his national supervisory authority that the use and/or failure of this "early" SESAR operational capability will not create unacceptable risk for ATM or airport operation. The results of this risk assessment might lead to necessitate under certain circumstances reversion to the baseline situation (normal operations) and as such this reversion shall be demonstrated to be safe for the ATM or airport operation. The impact of this reversion at aircraft and ground level will have to be addressed in a timely manner

(prior to the execution of demonstration exercises) as it may result in additional design requirements (airborne & ground) specific to the VLD. A Declaration of Verification/Conformity/Suitability for use for the ground system may be required when ATM operation is impacted by the VLD.

- Applicable Requirements for Airborne part:
  - Any new equipment to be used in the VLD will have to go through a full certification review process to ensure compliance with the applicable certification specification (e.g. CS-25/CS-23/CS-27/CS-29, subpart F). But, assessing this compliance, a more realistic intended use of this equipment will be considered. This might bring some technical challenges that will have to be solved on a case by case basis between the (Supplemental) Type Certificate holder and EASA during the certification review process.

For the sake of convenience, EASA will facilitate the coordination of VLD approvals and Authorities involvement with the different Authorities (NAAs, NSAs,...):

- Identifying specific applicable VLD requirements, means of compliance and guidance material
- Facilitating coordination between the relevant Authorities during the different phases of the VLD, in particular during the preparation and the approval.

Link to standardisation activities

The airborne and ground systems required to support the platform development for this demonstration should be based on existing standards where applicable. In the case where an update is envisaged to the standard the project should coordinate with the relevant standardisation body (eg EUROCAE) and provide feedback and any relevant material (eg demonstration reports etc) to the involved standards development group. Appropriate participation to the group should be envisaged by the project team.

An update of ED-133 is being developed by EUROCAE WG-59 with a planned publication in 2017. The project should therefore plan the appropriate participation and input of results into the working group.

Communication aspects

Each VLD project shall develop and implement a robust communication plan as each SESAR labelled VLD platform should be considered as the global “vitrine” for European leadership in ATM. The key headline to articulate the communication plan is “to see is to believe”. To that end the communication plan should acknowledge the need to reach out beyond the SESAR partnership. This will help building further confidence and buy-in from the main stakeholders on the readiness for larger scale deployment of the targeted SESAR solutions.

Efforts

In addition to the resources required for the execution of the Projects activities, Members have also to plan efforts for participating to activities beyond the Project scope such as attending to Governance Bodies (e.g. Programme Committee, Administrative Board) or performing financial reporting. The need to support any relevant coordination activities (e.g. input to standardisation bodies, link with regulatory authorities/EASA) must also be identified and planned.