SESAR JOINT UNDERTAKING

H2020-SESAR-2020-2 WAVE 3 Call Technical Specifications

Edition date: 13 March 2020
Edition: 01.00
Status: Approved

Abstract

This document defines the Technical Specifications for the SESAR 2020 IR VLD Wave 3 Call (H2020—SESAR-2020-2 WAVE 3).

The document is designed to offer to potential applicants a more detailed description of the Call specifications than can be found on the European Commission Research and Innovation Participant Portal. It contains detailed descriptions of all Topics to be awarded under the Call.

Table of Contents

Document history

Edition	Date	Status	Justification
01.00	13/03/2020	Final version	Final version for publication

1 Introduction

1.1 Purpose of the document

This document constitutes the Technical Specifications for the SESAR 2020 IR-VLD WAVE 3 restricted call (H2020-SESAR-2020-2 WAVE 3).

It captures the set of requirements that the potential applicants shall comply with and to offer a more detailed technical description of the Call requirements, which complements the information that can be found in the Single Programming Document (SPD) 2020-2022 and on the European Commission Research and Innovation Participant Portal. It contains comprehensive descriptions of all Topics to be awarded under the Call.

1.2 SESAR programme objectives and scope

The SESAR programme aims to ensure the modernisation of the European air traffic management (ATM) system by coordinating and concentrating all relevant research and development efforts in the European Union on ATM.

The SJU is responsible for the execution of the European ATM Master Plan and in particular for carrying out the following tasks:

- Organising and coordinating the activities of the development phase of the SESAR project in accordance with the European ATM Master Plan, by combining and managing under a single structure public and private sector funding;
- Ensuring the necessary funding for the activities of the development phase of the SESAR project in accordance with the European ATM Master Plan;
- Ensuring the involvement of civil and military stakeholders of the air traffic management sector in Europe and in particular; air navigation service providers, airspace users, professional staff associations, airports, the manufacturing industry and relevant scientific institutions and members of the scientific community;
- Organising relevant research and development to be carried out under its authority;
- Ensuring the supervision of activities related to the development of common products identified in the European ATM Master Plan, either through grants to members or other appropriate mechanisms following proposals to achieve specific programme objectives (in accordance with Regulation 1271/2013).

The Programme for SESAR 2020 is structured, as shown in figure 1, into three main research phases:

- **Exploratory research (ER)**: is focused on the investigation of relevant scientific subjects and on conducting initial definition and feasibility studies looking for potential application areas in ATM. It covers both fundamental scientific and application oriented research activities. The final goal is to transfer mature exploratory research results (typically at V1/TRL2 level) to the next phase, industrial research;
- **Industrial research (IR)** activities (executed within a Public-Private-Partnership (PPP) framework) encompasses the required validation and development activities to progressively

mature SESAR solutions up to V3 / TRL6, providing the required evidence to support the decision for further industrialization and deployment.;

- Finally, **demonstration activities at large scale (VLD)** showcase the SESAR solutions (concepts and technologies) in representative environments, confirm the performance benefits and identify the potential risks for the deployment of SESAR solutions delivered by the industrial research phase.
- In addition, and spanning these phases, there is a need for transversal activities working across the phases to ensure consistency, coherency and completeness and including aspects such as the ATM Design, performance framework and assessment and the maintenance of the European ATM Master Plan.

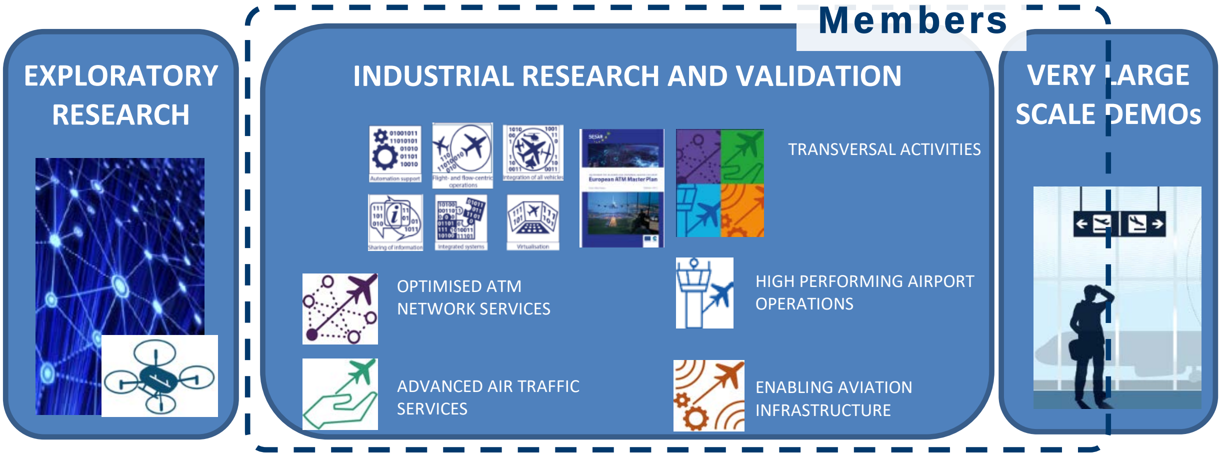

Figure 1 SESAR 2020 programme structure

This call covers Industrial Research activities and Very Large Scale Demonstrations activities.

SESAR Industrial Research and Validation (IR)

The industrial research activities in SESAR are designed to encourage the migration and development of ideas from Exploratory Research to higher levels of maturity, from concept definition, to operational and technical feasibility and finally to pre-industrial development. All the SESAR solutions follow a defined solution development lifecycle, which represents a sequence of major events enabling the research and development of proposed SESAR Solutions from their initial definition to their confirmed readiness (e.g. validated performance benefits) for further industrialisation and deployment.

Industrial research related activities are undertaken against a common structured framework to support the development of those SESAR solutions relevant for Air Transport evolution in an integrated manner, thus ensuring they are consistent, coherent and aligned with the ATM Master Plan vision and performance ambitions. This framework relies on a number of programme references such as the SESAR Concept of Operations or the SESAR Performance Framework, available in the programme library. 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 ensuring on-going robustness. The industrial research activities need to take also into consideration the ICAO Global Air Navigation Plan and relevant ICAO material, and relevant standardisation and regulatory activities, and for this reason, the SJU has established specific coordination links including the Members to these various organisations.

SESAR Very Large Scale Demonstrations (VLD)

Regulation 409/2013 calls for the maturity of ATM functionalities i.e. SESAR solutions 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.

The role of Very Large Scale Demonstrations (VLDs) is to bridge the research & innovation with deployment, and not to replace either type of activity. VLDs use early versions of end-user systems and include the integration of new technology elements into existing systems when needed and possible. The demonstration activities take also into consideration the ICAO Global Air Navigation Plan and relevant ICAO material. In particular, VLDs objectives are 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.

Some of the proposed VLDs may require the contribution from Airspace Users (AUs) who are not members of the SESAR JU. Unlike in the Wave 1 IR VLD call it is expected that the SESAR JU members will subcontract the required AU contribution for the VLDs described in this section (therefore the VLD open call is not intended to complement the VLDs in this Wave 3 IR VLD call).

1.3 Context

Maximising the potential of digitalisation is key to the future success of aviation throughout Europe and as such it represents the overall theme of the new ATM Master Plan 2020. The aviation industry is being transformed by digitalisation with increasing automation, and exchange of data amongst all parts of the Aviation value chain. But this is only the start and digitalisation will play an increasingly important role in the future safety and efficiency of the aviation industry. SESAR 2020 Wave 3 further contribute to the significant step (initiated in Wave 2) for the key European aviation stakeholders who must work together to ensure that the digital transformation of aviation does not become fragmented and pursue game changing ideas to meet the objectives of the EU's Single European Sky and Aviation Strategy.

The SPD 2020-2022 contained the list of research areas that framed the content to be developed under the scope of this IR/VLD Wave 3 Call (H2020-SESAR-2020-2). The scope for the IR VLD WAVE 3 is described in sections 2 and 3 of this document. The final call conditions are documented in the Single Programming Document 2020-2022.

The Wave 3 content is structured in a number of topics that contribute to the following key objectives:

- Complete ATM Master Plan 2015 key R&D needs,
- Address gaps in R&D to cover the Airspace Architecture Study (AAS) and/or new needs following the update of the ATM Master Plan 2020,
- Complement the activities in the scope of Wave 2.

It consists of one Work Area (WA) with a clear scope of activities structured at the level of Topics:

- 5 topics are related Industrial Research activities and they consist of research and innovation actions;
- 2 topics are related to Very Large Scale Demonstrations (VLD) and they consist of innovation actions.

The execution of IR VLD Wave 3 projects will take place during the period 2021-2022.

1.4 Overall scope

The list of candidate solutions and very large scale demonstrations for Wave 3 are structured in a number of topics that contribute to the following key objectives:

- Complete ATM MP 2015 key R&D needs;
- Address gaps in R&D to cover the Airspace Architecture Study (AAS) and/or new needs following the update of the ATM MP 2020;
- Complement the activities in the scope of Wave 2.

The results from the IR/VLD Wave 3 will contribute to set up a changed ecosystem for aviation and more specifically modernising the underlying air traffic management infrastructure. This ecosystem will be mainly build upon ATM solutions characterised by:

- Higher levels of autonomy and connectivity of all air vehicles coupled with a more automated management of the traffic;
- Digital and automated tools provided on board of the air vehicle itself or as part of the ground-based infrastructure;
- Virtual technologies to decouple the physical infrastructure such as sensors, communication or navigation devices from the services that are provided to manage the airspace;
- Big data analytics and open source data usage to encourage the creation of new services;
- System modularity to allow scalable and easier upgrades and greater interoperability.

The call covers 7 topics that include both Research and innovation Actions (RIA) and Innovation Actions (IA).

Research and innovation Actions (RIA): there are 5 topics that will validate, mature and deliver a number of SESAR solutions:

- SESAR-WAVE3-01-2020 Topic "Virtual Centre";
- SESAR-WAVE3-02-2020 Topic "Increased flexibility in the allocation of ATCO resources";
- SESAR-WAVE3-03-2020 Topic "Collaborative U-space-ATM interface";
- SESAR-WAVE3-04-2020 Topic "Enhanced automated air/ground synchronisation";
- SESAR-WAVE3-05-2020 Topic "Collaborative management of TMA & Airport throughput".

The candidate solutions covered by these topics have been selected due to their high potential on:

- ATM digitalisation: in areas such as innovation advancing automation, connectivity, information sharing, virtualisation, integration of all vehicles, lean and modular systems, etc.;
- ATM performance improvement: in areas such as environmental sustainability, capacity, cost-efficiency, operational efficiency, safety and security.

Innovation Actions (IA): there are 2 topics that cover "Innovation Actions" very large scale demonstrations:

- SESAR-WAVE3-06-2020 Topic "Integrated Runway Throughput and Terminal Efficiency";
- SESAR-WAVE3-07-2020 Topic "Downlinking Flight Trajectory for improved ATM performance".

Very Large Scale Demonstrations are designed to help bridging the gap between Industrial Research (development phase) and industrialisation / deployment. Therefore, they need to have clear links with the relevant delivered SESAR solutions (and the relevant data packs) that they intend to demonstrate. VLDs enable larger exercises to be conducted than those that are possible during IR validations, and multiple solutions can be demonstrated together. This tests solution scalability and increases buy-in from relevant stakeholders. Note that demonstration activities represent as well an opportunity to perform integrated validation for a number of SESAR solutions that have been validated individually until V3/TRL6 as part of Industrial Research.

An important aspect of the VLDs is the development of the local safety case in support of the introduction of the new concept in live operations, which may require regulatory approval. VLDs must follow the processes in the SESAR proof-of-concept document, and include in their demonstration report a description of any issues found along the way and how they were overcome.

2 Overall requirements

2.1 Justification principles

In line with the ATM Master Plan, the selection of the SESAR solutions covered by the proposal shall be justified according to the following set of principles:

- Demonstrating added value for the ATM network in particular about:
  - Defragmentation of service provision: promoting a common service architecture across the European ATM system;
  - Interoperability: enabling the seamless exchange of information between systems;
  - sharing of infrastructure: promoting the efficient and shared use of infrastructure such as CNS;
  - Scalability: delivering Solutions that enable the ATM System to be enlarged, to easily adapt operational capacity to meet demand.
- Demonstrating contribution to increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports;
- Demonstrating that the solution development will ensure a deployment oriented outcome.

The justifications provided for the selection in the proposals will be verified by the SJU and independent experts and will then be used during the evaluation under the 'Impact' award criteria, where the impact on performance is covered: "Degree to which the proposal demonstrates that the research will contribute to achieve the performance benefits outlined in the European ATM Master Plan".

2.2 Complementarity to Wave 2

In case of complementarity between Wave 3 and Wave 2 activities, the Wave 3 activities should directly contribute to the solution data pack to be delivered by the corresponding solution in Wave 2. While the Wave 2 projects (starting around January 2020) will deliver the full solution data pack, Wave 3 activities will deliver a specific exercise plan and report feeding the final version of the solution data pack. Wave 3 solutions shall reserve the required effort to close cooperate with Wave 2 in the elaboration of the solution data pack.

2.3 CNSS requirements

A close collaborative approach between the development of the candidate SESAR solutions and PJ.14 W2 Integrated CNSS shall be ensured and described in the proposals in order to:

- Identify Operational and Performance Requirements for Communication, Navigation, Surveillance and Spectrum;
- Ensure that the ATM Solutions plan and execute validation activities with due consideration of CNSS Performance capabilities e.g. potential impact of challenging traffic forecast on CNSS capabilities.

2.4 Cybersecurity

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 implementing, 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.

2.5 Standardisation and regulation

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 or technological 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.

The execution of validation activities and the elaboration of solution datapacks e.g. SPR-INTEROP/OSED and TS/IRS (that represent an integral part of the solution projects work) constitute their key contribution to the development of the relevant standardisation needs. 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 development work/activities.

2.6 Programme Execution Framework

The projects shall operate under the principles as outlined in the SESAR 2020 Project Handbook. The "SESAR 2020 project handbook" provides guidance explaining how SESAR 2020 projects shall be executed within the framework of the SESAR 2020 Research and Innovation (R&I) programme.

The main objective of the handbook is to provide a single entry point into the SESAR 2020 development framework for any SESAR 2020 project (selected as part of the IR/VLD wave 3 call for tender). In doing so the handbook aims to give an overview of what is expected from the project manager/solution leader and his/her team when defining, validating and reporting upon the development of SESAR Solutions in the context of SESAR 2020. The aim is to ensure an agreed and common approach across all projects to deliver the vision of ATM MP, allowing a uniform way of monitoring project execution as part of the overall programme, as well as supporting programme-level decision making.

In addition to the process described in the "SESAR 2020 project handbook", the following elements shall be considered:

- Technical baseline documentation

Proposals shall identify the reference documentation that will be used as the baseline for the research and development activities in wave 3.

VLD related topics include SESAR Solutions already validated within the SESAR programme. Full details of the SESAR Solutions can be found on the SESAR web site and their datapacks shall be the reference for the work in Wave 3.

Topics addressing SESAR Solutions that did not yet achieve V3/TRL6, shall refer to the latest applicable delivered (and public) datapacks by SESAR.

- Initial and target maturity levels

  Section 3 provides, per SESAR solution, the expected target maturity level at the end of Wave 3 that are captured in the Extended Release Strategy. The proposals shall define the required activities e.g. validation exercises to achieve this target maturity level. The proposals may deviate with respect to the proposed target, but shall clearly justify the reasons for this deviation with respect to the proposed target.

  Similarly, section 3 also proposes an indication of the initial maturity level expected at the start of Wave 3 activities. For those SESAR solutions that continue from Wave 1, this initial maturity level is based on the assumed progress of relevant projects at the end of Wave 1 that may not be finally confirmed. Proposals shall clearly state the initial maturity status and explain why the initial maturity is different from section 3.

- Deliverables confidentiality classification

  For the RIA actions, all solution datapacks (and the deliverables contained within) and the VALR shall be identified as “public” in the proposals.

  For the IA actions, the demonstration report shall be identified as “public” in the proposals.

  Any deviation from this principle e.g. deliverables defined as “confidential” shall be duly justified, and the proposal shall provide alternative means to ensure the required dissemination of the relevant results obtained under the execution of the action.

- Airspace Users contribution

  Some of the proposed topics may require the contribution from Airspace Users (AUs) who are not members of the SESAR JU. It is therefore expected that the SESAR JU members will subcontract the required AU contribution for these topics.

  Note that this is of special interest for the VLDs, given that, unlike in Wave 1, the VLD2 open call is not intended to complement the VLDs in this Wave 3 IR VLD call.

- SESAR proof-of-concept

  An important aspect of the VLDs is the development of the local safety case in support of the introduction of the new concept in live operations, which may require regulatory approval. VLDs must follow the processes as described in the SESAR proof-of-concept document (available in the Stellar programme library), and include in their demonstration report a description of any issues found along the way and how they were overcome.

3 Technical requirements

This section provides the descriptions of work of the topics to be addressed under this call.

3.1 SESAR-WAVE3-01-2020 Topic “Virtual Centre"

3.1.1 Problem statement and R&D needs

In today’s situation Air Navigation Service Providers (ANSPs) usually host a monolithic ATM system in each Air Traffic System Unit (ATSU) with very few information services and infrastructure elements being shared between the different centres. In the virtual centre 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, delegation of airspace or manage contingency situations. The development of technical services and common interfaces resulting from new technologies, working methods, and service oriented architectures (SOA) and procedures would also need to address human factors considerations.

3.1.2 Performance expectations

The solutions under the scope of this topic are expected to have a positive impact on the Network improving:

- The Virtual Centre Concept helps dynamically adapting to changes in capacity e.g. in case of contingency in an ATSU;
- Cost-efficiency thanks to the interoperability between system and the decoupling of the ATM data provision from the ATC service provision enabling data to be shared between different ATSUs.

3.1.3 SESAR Solutions

3.1.3.1 Solution PJ.32-W3-01 Virtual Centre - Complement of PJ.10-W2-93 Delegation of airspace amongst ATSUs

The Virtual Centre concept allows an innovative Virtual Centre architecture between a Virtual Centre ATSU and ATM Data Service Provider (ADSP), making it possible that a volume of airspace be controlled by one ATSU or another, e.g. depending on the availability of resources, or in order to provide service in the case of contingency. This is referred in the AAS as the “capacity-on-demand” service.

Complementarity:

The solution covers two threads of a different nature:

- An operational thread completing the scope of PJ.10-W2-93 and covering the ATFCM aspects of airspace delegation amongst ATSUs;
- A technical thread that is responsible for developing, verifying and integrating the required technical infrastructure to support the validation activities both under solution PJ.10-W2-93 in Wave 2 and PJ.32-W3-01 in Wave 3.

Thread 1: ATFCM aspects of airspace delegation amongst ATSUs

This solution will make it possible for two neighbouring ATSUs that can deliver service over the same volume of airspace to have a common cross-border rostering scheme. Note that the use cases under the scope of the solution are not only limited to cross-border ones but they include as well those where delegation between ATSUs can happen within the same ANSP. FMP support tools will consider the availability of ATCOs at any given time in both ATSUs when proposing a change of sectorization. This will increase the usability of the capacity on demand service.

This solution should also investigate the cross-border use of the Dynamic Airspace Configurations (DAC) concept. The objective is to make it possible to apply the DAC concept in a volume of airspace that is partly controlled by one ATSU and partly controlled by another ATSU, thereby increasing the number of potential configuration. The traffic demand and the availability of ATCOs on both ATSUs will be taken into account by the DAC tool when proposing a change of sectorization.

The exercises will compare a reference scenario with delegation of airspace but no FMP support for choosing the allocation of a sector to ATSU 1 and ATSU 2 against a scenario where there is FMP support, which considers availability of ATCO resources on both ATSUs, and potentially the cross-border DAC concept.

Economic, social and regulation impacts will be analysed.

Effort shall be allocated to coordinate with the Wave 2 solution PJ.10-W2-93 and shall coordinate with PJ.09-W2-44 in Wave 2 on DAC related aspects.

Virtual Centre - Delegation of airspace amongst ATSUs - ATFCM	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V1	V2

<u>Thread 2: Development of technical infrastructure to support the validation of Virtual Centre.</u>

The main objective of this thread is to develop the required technical infrastructure to support:

- The V3 validation activities planned to be performed by Wave 2 solution PJ.10-W2-93 on the ATC aspects of airspace delegation amongst ATSUs;
- The V2 validation activities planned to be performed under Thread 1 of this solution in Wave 3 on the ATFCM aspects of airspace delegation amongst ATSUs;

The activities under this thread include:

- Support PJ.10-W2-93 and the activities in thread 1 on the definition of the appropriate validation environment to conduct the above mentioned validation exercises aiming to get a maximum coverage of Use Cases in the Virtual Centre environment e.g. using multiple ADSPs of different vendors to deliver services for the same Virtual Centre ATSU or the same ADSP Virtual Centre delivering services to different ATSUs of different vendors;
- Provide technical support to PJ.10-W2-93 and the activities in thread 1 regarding the service definition and feeding back to their TS/IRS (including relevant SDDs);

- Development of the required technical infrastructure e.g. prototypes and validation platforms to support validation exercises;
- Perform the required integration and verification activities on the technical infrastructure to ensure their readiness for the execution of the validation activities;
- Perform technical validation activities to ensure that the required quality of service is met, in particular for the transfer of data between geographically separated locations, remote installation of HMI, remote supervision, transversal technical features as recording;
- Contribute to security assessments: as the Virtual Centre concept is based on new external interfaces, it is important to consider how potential cyber-threats could affect these interfaces and how they can be counteracted and effectively mitigated.

Expected benefits

- Capacity and resilience. The solution should provide as well benefits in terms of cost efficiency (improved ATCO productivity) to be confirmed by the validation activities.

Coordination between Wave 2 and Wave 3 Projects

Given that the ATFCM aspects of airspace delegation amongst ATSUs are not considered to be at a lower maturity level than the ATC ones, thread 1 in Wave 3 shall deliver a typical solution datapack at V2 level including SPR-INTEROP/OSED and TS/IRS, and the required VALP and VALR. Strong coordination between the solutions in Wave 2 and Wave 3 is required to avoid overlaps and/or inconsistencies.

Thread 2 is not expected to deliver a solution datapack but the required availability notes demonstrating the technical infrastructure readiness to support the validation activities in PJ.10-W2-93 and in thread 1 of PJ.32-W3-01.

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

<table>
<tr><th colspan="2">Principles</th><th>How does the solution contribute to these principles?</th></tr>
<tr><td rowspan="3">Added value for the ATM network</td><td>Defragmentation of service provision</td><td>The use of Virtual Centre Architecture leads to an efficient use of ANSP infrastructure that tackles the issues presented by fragmented European ATM systems and country-specific architectures, enabling Europe to move to an interoperable, cost-efficient and flexible service provision infrastructure.</td></tr>
<tr><td>Interoperability</td><td>The Virtual Centre ATSU needs to interface with one or more data service providers or consumers. This is possible with a service-oriented approach with a focus on the technical services and common interfaces. By using standard interfaces, interoperability increases significantly.</td></tr>
<tr><td>Sharing of infrastructure</td><td>By sharing development in an ADSP, multiples ATSUs could access to innovative functions more rapidly.</td></tr>
</table>

	Scalability	Open architecture guarantees the long-term upgradability and scalability of the solution, and its ability to consider future services required from other R&D activities.
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		Yes. The Virtual Centre Concept helps dynamically adapting to changes in capacity e.g. in case of contingency in an ATSU.
Deployment oriented outcome		The solution supports the automation and digitalisation concepts in support of the Airspace Architecture Study (AAS) and provides a solid foundation to the next generation of ATM provision and related methodologies.

Relevant links to the ATM Master Plan Level 2 (DS19p):

The scope under this solution is a required enabler to support the Key R&D need identified in the ATM Master Plan 2015 “Workstation, service interface definition and virtual centre concept” and to ATM Master Plan 2020 EOC “Virtualization of service provision”.

This new SESAR Solution needs to be created together with the required Operational Improvements steps (OIs) for future datasets.

3.2 SESAR-WAVE3-02-2020 Topic “Increased flexibility in the allocation of ATCO resources”

3.2.1 Problem statement and R&D needs

The current operation requires that controllers hold both a licence for a particular rating (e.g. Approach Control Surveillance (APS), Area Control Surveillance (ACS)) and then a validation that permits that person to exercise their licence in defined volumes of airspace. The need for sector-specific training is not the only limiting factor: once a controller has been trained for a defined volume of airspace, he or she needs to stay current. The AAS points to the need to control for a specific number of hours in a sector to maintain currency as being a key limiting factor:

> Once a controller is validated for a sector, he or she will need to actually control on that sector a minimum number of hours per period (e.g. 30 hours every six months) in order to stay current. The minimum number of actual control hours required for maintaining what is called the unit endorsement for a sector is established by the National Supervisory Authority (NSA) and depends on the complexity of each sector. When a controller does not fulfil this minimum number of hours, e.g. due to sick leave, maternity leave, or non-operational duty assignments at the ANSP, he/she needs to be retrained for the sector before being able to control on it again (AAS, section 3.3.3).
>
> The larger the number of sectors a controller is endorsed for, the more flexibility for rostering the ANSP will have on any given day (because the controller can be assigned to work at any of the sectors he/she is endorsed for). However, rostering also needs to ensure that controllers maintain the endorsement on all the sectors they can work at; this becomes harder the more sectors each controller is endorsed for. As a consequence, there is a limit to the number of

sectors that it is practical to endorse a controller for, and European ANSPs providing service to large geographical areas typically have their airspace divided in sector groups, with each controller being able to work only in one of the sector groups (AAS, section 3.3.3).

3.2.2 Performance expectations

The solutions under the scope of this topic are expected to have a positive impact on the Network:

- The increased flexibility in rostering delivered by the solution is expected to finally result in increased capacity with the same ATCO resources.

3.2.3 SESAR Solutions

3.2.3.1 Solution PJ.33-W3-01 Increased flexibility in ATCO validation

The AAS sets the objective of increasing the flexibility of allocation of ATCO resources by limiting the ATCO's need for sector-specific knowledge and currency requirements. The ultimate objective is tying ATCO validation to a specific system rather than a specific geographical area, and potentially to a specific traffic complexity and/or type of sector. Wave 1 solution PJ.10-06 has researched this concept, and Wave 2 PJ.10-W2-73-NGCV continues PJ.10-06 targeting V2 but with a reduced scope.

The following elements could be part of the scope of this Wave 3 solution:

1) Procedural and airspace design enablers to limit the differences in operations between different sectors, geographical areas or sector configurations, as well as for reducing the complexity of the controller task;

2) More detailed documentation in support of operations, e.g. development of checklists, description of usual conflicts and the usual ways to solve them, creating documents based on radar replays showing typical conflict scenarios;

3) System support to make the more detailed information more readily available to controllers in real-time (on-the-job context-dependent information);

4) Increased automation of conflict detection and resolution, providing in particular support to deal with typical sector-specific situations, e.g. by highlighting problematic flights and providing specific support on best practices for handling them. This would apply not only to conflict detection and resolution, but also to conflict prevention, e.g. avoid clearing flights on routes/flight levels that are known to be problematic (i.e. likely to cause conflicts), even when there is no conflict at the time the clearance is given. Note that conflict prevention would usually be tied to traffic load, so that the higher the traffic load, the more preventive clearances would be given; however, conflict prevention strategies can't be considered a complexity-reducing measure (they reduce *potential* complexity).

5) Availability of on-hand support by expert controllers in each sector, e.g. having supervisors with detailed knowledge specializing in a sector group, while controllers are validated to work for a wider sector group, or combining controllers with detailed sector expertise with controllers with less detailed sector knowledge. For example, for sectors manned by the traditional planner-executive team, it may be possible that executive be required to be more expert than the planner (i.e. in a large area control centre, it may be possible that all ATCOs be validated to work as planners in all sectors, while they can only work as executives in one

sector group). This should consider how rostering would be affected when concurrent unit validation schemes are in operation.

6) Complexity-based validation, e.g. accepting that controllers holding a licence to work for a larger geographical area and/or for more sector configurations may not be able to handle as much traffic as they do today. This could be used both in contingency, for providing partial service (e.g. at night), and in normal operations. For example, in busy airspace controllers with a wider validation could open a lower-capacity offload sector, e.g. to provide 0% of the capacity. This could be combined with the full capacity validation, i.e. controllers in a large ACC could be validated for a whole sector group for full capacity as they are today, and for all sectors in the ACC for reduced capacity, e.g. at night.

The SESAR solution “Increased flexibility in ATCO validation“ aims at developing and validating to V2 an initial concept that takes some of the elements above in order to increase the flexibility in the ATCO validation regime. The solution will allow ATCOs to be validated to work in a larger geographical area, number of sectors or sector configurations than they do today, increasing the flexibility of the controller-licensing scheme and optimising ATCO qualifications for a higher number of airspace configurations. This concept has been researched in Wave 1 by PJ.10-06 and has reached V1 maturity.

The scope in Wave 3 should be divided into two threads:

- Thread 1: Increased flexibility in ATCO validation for full capacity: the development and specification of the required human, system and procedural enablers that would allow the increase the size of the geographical area or the number of sectors or sector configurations that each ATCO is validated for by reducing the number of effective hours required to maintain the validation for working at full capacity.

  It is expected that this thread will require the development of system support as per bullet points 3) and 4) above. The development of CD&R tools is in scope for this solution, but it can’t merely be an extension of the developments in PJ.10-W2 and PJ.18-W2. For this solution, the focus must be on CD&R tools and conflict prevention tools that incorporate sector-specific knowledge, e.g. best practices for conflict resolution in a sector could be incorporated to the CD&R logic, considering for example the usual lateral revision patterns, the typical intermediate altitudes that aircraft are cleared to for conflict resolution or conflict prevention purposes, etc. Coordination tools are also in scope, and should consider the output of Wave 1 solution PJ.10-01c and the coordination with PJ.10-W2.

  A major input for the development of the system support will come from the analysis of on-the-job training sessions where on-the-job training instructors (OJTI) train experienced controllers for getting their validation in a new sector.

  A major challenge that needs to be overcome is the dynamic nature of sector-specific information, which is the reason why it is currently not documented in the first place, e.g. best practice changes as traffic patterns change or airlines implement new policies, and ATCOs adapt their practices (e.g. usual levels to clear aircraft to, new lateral revision patterns) by regularly working on the sector as per the NSA’s minimum requirements. It is expected that AI should be used for the purpose of identifying the relevant information that can be provided as support and for the purpose of monitoring that the information provided remains relevant, but there is no previous work in this domain.

There is a risk that the introduction of these support tools results in a reduction of the adaptability of ATC operations to changing traffic patterns or airline policies. The impact this may have on safety and efficiency needs to be considered.

- Thread 2: Increased flexibility in ATCO validation for reduced capacity: this thread will focus on making it possible for ATCOs to maintain currency for reduced capacity for providing contingency service or for consolidation of sector-groups or ATC facilities at night or other periods of low demand. This should consider state of the art of existing sector/facility consolidation practices, e.g. ATSUs currently providing service to a TMA and closing during the night, so that the service is provided by another ATSU. It is expected that this thread will not require the development of system support tools as per bullet points 3) and 4), but their development is in scope if deemed useful.

In both threads, the solution should also address enhancements to the currency scheme and corresponding rostering strategies, considering, for example:

- In some cases, effective hours worked in a geographical area may also be relevant for staying current in a neighbouring geographical area (e.g. because at least the controller is staying fully current in the coordination conditions between the two areas).

- Work in a geographical area with a specific sector configuration may also be relevant for staying current in the same geographical area but with a different sector configuration. There are examples where this is already applied today, e.g. on approach sectors, where the change of the runway in use may completely change the method of operation (applicable minima, procedures, coordination needs…), but for maintaining currency the hours count the same regardless of the runway in use.

- The traffic loads on a sector could also be considered for weighting the value of hours towards maintaining currency, e.g. to make busier worked hours count more than less busy worked hours, allowing the substitution of effective worked hours in the sector by simulator hours…

- It may be possible to split the required on-the-job effective hours for maintaining currency between hours of work in the geographical area (regardless of the sector and/or configuration) and hours worked in a specific sector in the area, or configuration or group of configurations.

For both threads, the main metric whose reduction is targeted by this solution is “number of hours required to maintain currency”. The connection to ATCO productivity is explained by the AAS:

> The availability of ATC Capacity across the network tends to be rigid while traffic demand is variable, both predictably and unpredictably. This results overall in spare capacity and excess load (AAS, section 3.3.3).

In some ATC facilities, controllers rotate over very few sectors, and the NSA may not have found it necessary to establish stringent currency requirements (because controllers work in so few sectors that so long as they continue to exercise the privileges of their licence they are considered to be always current). In this case, the solution must consider in their safety assessment how having controllers validated for an increased number of sectors may affect safety compared to current operations, potentially deriving which currency requirements would be needed to ensure safety. The basis for the performance assessment would be the comparison of those currency requirements in a hypothetical baseline where controllers were validated for more sectors than today against the reduced currency requirements made possible by the solution.

Building on PJ.10-06 activities and in coordination with PJ.10-W2-73, the solution should also investigate smart sector grouping schemes, where the increased flexibility does not come from controllers being validated for a larger geographical area and/or more sector configurations than they are today, but from the introduction of new sector groupings (with intersections) that increase the flexibility in rostering.

The productivity increase brought by this solution will not come from increasing the number of aircraft that one team of ATCOs can handle, but by reducing the underutilization of ATCOs that happens when a volume of airspace is overloaded while another volume is under-loaded. In this situation, the controllers assigned to the under-loaded volume can't be reassigned to the over-loaded volume because they do not have a licence to work in that volume.

This increased flexibility in rostering facilitates the allocation of controllers to where there is traffic demand within a single ANSP and/or across ANSPs (through the capacity-on-demand concept in the AAS (sections 6.4.1 and E.3.4), as well as the consolidation of ATC facilities during periods of low demand, which would finally result in increased capacity with the same ATCO resources. Both the capacity-on-demand service and the consolidation of ATC facilities at periods of low demand are enabled by the virtual centre concept, under development by PJ.10-W2-93. The solution also supports the Dynamic Airspace Configurations (DAC) concept by allowing more flexibility in sector configurations than in current operations.

These gains in productivity will not be measurable with the current SESAR metrics. The solution shall reserve effort to translate the "number of hours required to maintain currency to work in a sector" into "size of the geographical area and/or number of sector configurations that a controller can be validated for", and to then build on PJ.10-06 work to translate the "size of the geographical area and/or number of sector configurations that a controller is validated for" into productivity gains. In addition, the solution must coordinate with PJ.19 to facilitate the inclusion of their approach in future updates of the SESAR performance framework. In the performance assessment, the solution shall consider the potential impact on fuel burn; for the reduced capacity thread, the trade-off between cost-efficiency and capacity shall be considered. The maintenance of the current level of safety is required.

The initial VALP for V2 delivered by PJ.10-06 at the end of Wave 1 is a key input for the work in Wave 3. The proposal must explain how this solution will complement with the work in thread C of PJ.10-W2-73 "Flight-centric ATC and Improved Distribution of Separation Responsibility in ATC", which includes a limited set of follow-up activities of the PJ.10-06 output. The concept is applicable both intra-ATSU (e.g. to enable controllers in a large ACC to be validated for a larger geographical area and/or more sector configurations than today) and inter-ATSU (e.g. to enable controllers from one ACC to be able to be validated to work in a geographical area for which air traffic control is provided from another ACC, be it from the same ANSP or from a different ANSP). For the inter-ATSU concept, the concept may consider the controllers physically changing to provide service in one ATSU or another, or be combined with the virtual centre concept, so that an area of the airspace may be controlled from one ATSU or another ATSU. The Inter-ATSU concept is expected to allow regular take-over (e.g. daily at night or seasonally one ATSU could be taken over by another ATSU), and potentially also dynamic takeover (depending on staff availability some areas could be controller from one ATSU or another). Coordination with PJ.10-W2-93 "Delegation of airspace amongst ATSUs", which addresses the virtual centre concepts, must be ensured. Coordination with the "Generic controller validations" solution is also required.

In an environment where controllers are able to work in a larger geographical area and/or for more configurations than they are today, it would be useful to closely monitor the level of "advanced situation awareness". The solution should also research methods to gain "real-time" data on subjective and objective level of situation awareness and workload, e.g. to be displayed in the supervisor's console.

Even though the reduction of the training time required for an ATCO to be trained for a new sector is not the objective of this solution (because training is a one-time effort), it is expected that the tools developed by this solution may be useful for training. Note that the training use case does not represent the core of the solution. It is understood that it can support the business case and, as such, it could be addressed as a complementary use case. It is expected that no regulatory changes will be required for the deployment of this solution.

Increased flexibility in ATCO validation	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V1	V2

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	N/A
	Interoperability	N/A
	Sharing of infrastructure	N/A
	Scalability	The solution aims at increasing the flexibility in rostering enabling the allocation of controllers to where there is traffic demand within a single ANSP and/or across ANSPs (through the capacity-on-demand concept in the AAS, as well as the consolidation of ATC facilities during periods of low demand).
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The increased flexibility in rostering delivered by the solution is expected to finally result in increased capacity with the same ATCO resources.
Deployment oriented outcome		The solution is one of the cornerstones of the Airspace Architecture Study (AAS); it represents a first step in the Sector Independent Controller Validations, and will enable the partial deployment of the "Capacity-on-demand" service as foreseen in the AAS.

Relevant links to the ATM Master Plan Level 2 (DS19p):

The scope under this solution contributes to complete the work on one of the Key R&D needs identified in the ATM Master Plan 2015 "Generic (non-geographical) controller validations" and to the ATM Master Plan EOC "Fully dynamic and optimised airspace".

This SESAR Solution follows-up the work performed by SESAR Solution PJ.10-06 in Wave 1 and covers the following OI steps:

- *SDM-0203 — Generic' (non-geographical) Controller Validations.*

3.2.3.2 Solution PJ.33-W3-02 Generic Controller Validations

This solution builds on the same elements that have been identified as being relevant for the solution "Increased flexibility in ATCO validations", but represents a fundamental change of paradigm. The generic controller validations concept proposes to completely move away from the concept of controller unit validations. In order to achieve this goal, the geo-specific aspects of air traffic control would need to be removed as much as possible, and for those that remain adequate mitigations would need to be put in place to allow ATCOs to maintain a safe, orderly and efficient flow of air traffic in spite of having no local knowledge.

The concept would allow an ATCO to work any airspace, anywhere, in Europe (or the world), whether managed with traditional sectors or without sectors, according to the flight-centric ATC concept, provided the controller held the appropriate rating for the position.

It is essential that the controller be trained and familiar with the particular CWP and available support tools. This aspect is covered in current operations by the unit rating, because the CWP and set of tools are specific to each area of airspace. For the generic controller validations concept, it is anticipated that the rating scheme would have to be adapted to encompass higher granularity than it has today, so as to include the tools that the controller has been trained to work with. The new rating scheme may also include limitations in the airspace that the licence can be exercised, but these limitations should not be geographic; for example, there may be a need to split the Area Control Surveillance Radar (ACS RAD) rating into multiple ACS RAD ratings, to cover different CWP types or even different sector types, e.g. there could be a new ACS RAD for a specific CWP and limited to high altitude sectors – above FL350).

This solution will make it no longer required that ATCOs work a minimum number of hours on a specific sector or flight-centric area for him or her to be able to provide air traffic control; instead, it is expected that there would be a generic currency requirement, so that controllers would need to exercise their rating for a minimum number of hours per period in order to stay current as controllers with the set of tools associated to their rating, rather than current in a specific geographical area. This flexibility would allow a better distribution of ATCOs across the world through workforce deployment as and where needed according to the traffic requirements. PJ.10-06, through their validation exercises, identified a list of technical, operational, airspace and procedural needs that would support the reduction of the geo-specific aspects, and this will be the starting point for this solution. Changes to training and regulation would be necessary to allow the implementation of this concept.

For this solution, the metric "number of hours required to maintain currency to work in a geographical area or with a specific sector configuration" is not relevant. The solution should quantify the benefits in terms of controller productivity by considering the benefits that having controllers being able to work anywhere in the world would have, not only in terms of rostering, but also in terms of flexibility for moving ATCO resources between ANSPs, as well as the potential benefits that could be realised from combining this concept with the virtual centre concept, so that controllers could provide service anywhere in the world from the same CWP (located in one ANSP) without prior training for the geography of the area.

Like for the solution "Increased flexibility in ATCO validations", the maintenance of the level of safety is required. The potential impact on fuel burn shall be considered. The solution shall consider the impact on both ATC Capacity (number of aircraft in an area with a specific number of controllers) and Airspace Capacity (maximum number of aircraft in a geographical area, assuming there are as many controllers available as needed to man all the available positions).

This concept has been researched in Wave 1 by PJ.10-06, having reached a maturity of V1 ongoing. The target maturity for Wave 3 is V1.

Generic controller validations	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V1 ongoing	V1

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	N/A
	Interoperability	N/A
	Sharing of infrastructure	N/A
	Scalability	The solution aims at dramatically increasing the flexibility in the allocation of controllers to where there is traffic demand within a single ANSP and/or across ANSPs (through the "capacity-on-demand concept" in the AAS, as well as the consolidation of ATC facilities during periods of low demand), as well as facilitate the worldwide mobility of controllers.
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The increased flexibility in the allocation of controller resources delivered by the solution is expected to finally result in increased ATC capacity, i.e. more traffic will be handled with the same ATCO resources.
Deployment oriented outcome		The solution is one of the cornerstones of the Airspace Architecture Study (AAS). The full deployment of the Sector

	Independent Controller Validations is required for the full deployment of the AAS.

<u>**Relevant links to the ATM Master Plan Level 2 (DS19p):**</u>

The scope under this solution contributes to complete the work on one of the Key R&D needs identified in the ATM Master Plan 2015 "Generic (non-geographical) controller validations" " and to the ATM Master Plan EOC "Fully dynamic and optimised airspace".

This SESAR Solution follows-up the work performed by SESAR Solution PJ.10-06 in Wave 1 and covers the following OI steps:

- *SDM-0203 — Generic' (non-geographical) Controller Validations.*

3.3 SESAR-WAVE3-03-2020 Topic "Collaborative U-space-ATM interface"

3.3.1 Problem statement and R&D needs

The demand for drone services is steadily increasing, with the potential to generate significant economic growth and societal benefits, as recognised in the 2015 EU Aviation Strategy, and in the 2016 SESAR Drones Outlook Study and Warsaw Declaration on drones. In order to realise this potential, the Declaration calls for "urgent action on the airspace dimension, in particular the development of the concept of U-space". Ultimately, U-space will enable complex drone operations with a high degree of automation to take place in all types of operational environments, including urban areas. U-space must be flexible enough to encourage innovation, support the development of new businesses and facilitate the overall growth of the European drone services market while properly addressing, at EU level, safety and security issues, respecting the privacy of citizens, and minimising the environmental impact.

3.3.2 Performance expectations

The delivered solutions are expected to have a positive impact on:

- Access and equity enabling high-density operations with multiple automated drones under the supervision of fleet operators.

3.3.3 SESAR Solutions

3.3.3.1 Solution PJ.34-W3-01 Collaborative U-space-ATM interface

U-space is defined as: 'a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones'. The nature of these services, and the way that they will be delivered, is still under research and development, but the European vision is that the provision of U-space services to drones will be provided by multiple service providers, all working within a common architecture using standardised interfaces and procedures. Nevertheless, it is clear that, for U-space to reach its potential, U-space services must interface with the existing manned aviation environment, including ATM (including ATC, AIM and ATFCM) and it is that interface that is the focus of this Solution.

U-space information exchanges have been defined and (partly) validated / demonstrated in various demonstration projects but could result in diverging implementations, due to the lack of a harmonised approach amongst these initiatives. This jeopardises an interoperable and seamless UTM service provision.

This solution validates the exchange of UTM information through harmonised SWIM information services between various UTM stakeholders such as drone operators, UTM service providers, ATM service providers, data service providers, aeronautical data providers and authorities.

It is the objective of this solution to bring U1, U2 and U3 services to the level of SWIM candidate information services. In addition, the solution will validate those services required by Advance Services Collaborative interfaces with ATM. As such, the solution proposes an end-to-end approach from data availability to data usage with the objective of ensuring interoperability between U-space and ATM for avoiding airspace fragmentation.

The solution shall address three activities:

- A literature review and description of the state of the art;
- The definition of the Portfolio of harmonised U-space (U1, U2 and U3) SWIM candidate information services supporting a collaborative interface between U-space and ATM;
- The validation of this portfolio focusing on U-space U2 and U3 Advance Services Collaborative interfaces with ATM.

Activity 1: Literature review and state of the art

The first activity consists of an in depth analysis and description of the European and worldwide state-of-the-art through literature review, expert groups and interviews with experts and stakeholders.

This activity includes particular emphasis on incorporating the output of the following SESAR activities:

- Analyse the background work on interoperability and data exchanges from the related SESAR U-space projects and initiatives, including those collected through EUROCONTROL Special attention shall be paid in particular to the outcome of projects IMPETUS, DROC2OM, SAFIR, VUTURA, DREAMS, TERRA, SECOPS and GOF U-space;
- Assess the available list of potential services (e.g. CORUS list of services, architecture, roles and responsibilities) and the relevant information exchange requirements, their maturity status, etc. and the identification of potential gaps and/or issues.

This activity must include a consultation activity involving third parties (FAA, NASA, SMEs, etc.) to provide input for their ATM-UTM interface requirements.

Activity 2: Definition of a portfolio of the candidate services supporting a collaborative interface between U-space and ATM

This activity includes the following activities:

- Building upon the results of activity 1, identify the use cases and their Information Exchange Requirements, with particular attention to the interface with ATM;

- Definition of SWIM U-Space functional and non-functional requirements associated to the required information services;
- Identification of cybersecurity threats and definition of associated risk controls;
- Develop the service definitions for those SWIM candidate services that allow further service standardisation;
- Selection of the services to be validated in activity 3.

Activity 3: Validation of the selected services.

While activity 2 addresses the data exchanges and data availability between stakeholders, this activity focuses on ATM stakeholders accessing the data/information available from the SWIM U-space candidate services.

The activity shall:

- Upgrade selected U2/U3 services to SWIM U-space candidate services by implementing the UTM side of the interoperable collaborative ATM interface;
- Validate U2/U3 – Collaborative/cooperative Interface for ATM through which the ATM stakeholders will interact with the other SWIM U-space candidate services;
- Validate the availability and fitness for purpose of the SWIM U-space candidate interface service definitions through the collaborative interface, e.g. though model-based simulation or test-harness, addressing for example:
    - UAS operation authorization/validation whatever the type of airspace (e.g. it should be seen as an extended version of U2: Flight Plan Management);
    - UAS operation tactical monitoring in controlled airspace including handover from/to UTM/ATM;
    - UAS operation impact on traffic flows (DCB will take into consideration UAS traffic);
    - On-demand service of airspace design for supporting UAS operation in ATC controlled airspace;
    - Management of separation between manned traffic and UAS flying under U-space in controlled airspace, e.g. in the vicinity of airports.

To this end, the support activities will focus on:

- Definition of safety and cybersecurity requirements applicable to data/information accessible through U3-Collaborative interface for ATM from SWIM U-space;
- Development of a web service client for the proposed SWIM U-space candidate services;
- For information to be displayed to ATCOs, assessment of human factors impact;
- Definition of the procedures to manage alerts/instructions from/to ATM to/from U-space services providers.

U4 services are not under the scope of the solution.

The consortium shall ensure coordination with other U-space stakeholders beyond the SJU members to ensure the solution represents all stakeholders needs and expectations. The solution will contribute to the relevant standardization bodies.

The proposal shall consider effort for coordination with ER4 projects that will work on U3 services.

It is acknowledged that the scope of the solution is very wide, and therefore it should not be able to reach V3 maturity at the end of Wave 3 for all the services in the portfolio. However, it is expected that some elements of the solution will reach V3, and these must be documented in a V3 datapack. The solution should therefore plan to deliver both a V3 datapack for the services that are ready to progress to further industrialization and deployment and a V2 datapack for those that are not.

Collaborative U-space-ATM interface	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V1	V2/V3

The solution contributes to this set of key principles in line with the ATM Master Plan 2015:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	Harmonised U1-U2-U3 services form the cornerstone of the CORUS architecture and will enable a true seamless airspace as envisioned by the Airspace Architecture Study, for all airspace users including drone operators, for all type of operations in all airspace area(s) (from ground to upper class E operations). The seamless provision of the needed information services between stakeholders of the airspace management (both ATM and stakeholders USSP) is also an essential step for supporting large-scale operations and cross-border operations of drones in Europe.
	Interoperability	The solution enables the seamless exchange of information between systems: interoperability is ensured through SWIM U-space information services whose design and implementation are aligned with the applicable SWIM standards, including the information service payload being traced against AIRM.
	Sharing of infrastructure	Not applicable

	Scalability	With Harmonised U1-U2-U3 SWIM U-space services, traffic demand from drone operators and the number of USSP can be accommodated through making the services independent (Service Oriented Architecture) from the infrastructure, and through scalable resources (platforms, clouds, etc.).
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The solution contributes to enable high-density operations with multiple automated drones under the supervision of fleet operators.
Deployment oriented outcome		Delivering validated and harmonised U1-U2-U3 SWIM U-space information services will accelerate the deployment of the U-Space roadmap in Europe.

Relevant links to the ATM Master Plan Level 2 (DS19p):

U-space was not defined at the time the ATM Master Plan 2015 was endorsed. However, it is one of the cornerstones of the ATM Master Plan 2020 and this solution contributes to the ATM Master Plan EOC "U-space services".

This new SESAR Solution needs to be created together with the required Operational Improvements steps (OIs) for future datasets and/or refined the relevant U-space services available in DS19p.

3.3.3.2 Solution PJ.34-W3-02 Collaborative ATM U-space Environment Concept Development

The objective of this solution is to develop the U-space-ATM collaborative concept. The solution activities shall build on and further develop the CORUS Concept of operations, with a particular focus on ensuring the safe, simultaneous operation of drones and manned aviation in the new collaborative environment. This should cover operations inside and outside controlled airspace, further defining the interface between ATM and U-space, as well as examining the corresponding information-exchange concept and requirements. Since U-space implementation is anticipated to be dependent on high levels of automation, the opportunities for, and the impact of automation on the ATM and U-space systems in support of the new information exchange and operational concepts are also in scope.

The work shall include the analysis of the new U-space regulations and EUROCAE standards, to assess their impact on ATM and the associated research and development needs:

- The potential interactions between the European regulation and the ICAO framework, considering in particular airspace classification and their associated service and equipage requirements.

- The provision of U-space services within and outside controlled airspace where the ANSPs currently provide services, with a view of defining how the new U-space services, including in particular U-space traffic information services, could be a applied safely, and how the current ATS services and the U-space services would complement each other.

- Complementary of the roles and responsibilities of the U-space service providers and the ATS service providers with respect to local authorities where both ATS and U-space services are provided.
- Airspace requirements, including potential impact on airspace access rules (and potential extension of Danger or Prohibited areas to protect drone activity), potential need to define new types of areas, and need to manage access to danger or prohibited areas or the new types of areas by manned aviation to which the ANSP provides ATC or advisory service and drones that use U-space services.
- Altimetry requirements for U-space and their impact on the ATM-U-space interface and the coordination between manned aviation and drones.
- Operational aspects of the U-space – ATM collaborative environment, including in particular where applicable responsibility for separation and development of separation minima, as well as trajectory revision and update processes.
- U-space resilience principles and their impact on ATM.
- Impact of geographic vs. magnetic navigation concepts for the ATM-U-space interface, and elaboration of associated requirements.
- Impact of drone route definition, formatting and navigation performance options on the U-space-ATM interface and elaboration of associated requirements.
- Development of requirements for surveillance and tracking for drones, definition of how tracking is to be used, and the impact of drone tracking on manned aviation operations and on the ATM/U-space interface.
- Handling of military sensitive information in the ATM-U-space interface.
- Impact of weather on drone operations and on the collaborative ATM-U-space interface, including requirements on the quality of weather information.
- Evolution of the flight-rules framework to account for drones and their different modes of operation.
- Evolution of the SESAR access and equity framework, in order to extend its applicability to the areas where both U-space and ATM services are provided.

Involvement of the wider drone community is essential to successful completion of this project. As a consequence, proposals must describe how appropriate representation of the full range of U-space stakeholders will be ensured.

Proposals must indicate how they will engage with EASA to ensure that the research is harmonised with ongoing development work, including in particular the work on geographical zones. Description of how the solution will engage with standardization bodies is also required.

Proposals must describe how appropriate representation of U-space stakeholders will be ensured.

Collaborative Environment Development ATM U-space Concept	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V1	V2

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	The solution aims at further developing the U-space concept of operations and will enable a true seamless airspace as envisioned by the Airspace Architecture Study, for all airspace users including drone operators, for all type of operations in all airspace area(s) (from ground to upper class E operations).
	Interoperability	Not applicable
	Sharing of infrastructure	Not applicable
	Scalability	Not applicable
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The solution contributes to enable high-density operations with multiple automated drones under the supervision of fleet operators.
Deployment oriented outcome		Delivering validated and harmonised U1-U2-U3 SWIM U-space information services will accelerate the deployment of the U-Space roadmap in Europe.

Relevant links to the ATM Master Plan Level 2 (DS19p):

U-space was not defined at the time the ATM Master Plan 2015 was endorsed. However, it is one of the cornerstones of the ATM Master Plan 2020 and this solution contributes to the ATM Master Plan EOC "U-space services".

This new SESAR Solution needs to be created together with the required Operational Improvements steps (OIs) for future datasets and/or refined the relevant U-space services available in DS19p.

3.3.3.3 Solution PJ.34-W3-03 "Higher airspace" operations

Demand for use of very high-level airspace has increased in the last years, and this trend is expected to gain momentum in the coming years. ICAO has provisionally adopted the term 'higher airspace' to refer to that volume of airspace between airspace where ATM provides services (typical upper level of FL600) and the boundary between airspace and space (approximately 100 km2). AU operating in this airspace are sometimes referred to as 'New Entrants', and have many different operating characteristics, such as unmanned HALE vehicles providing internet coverage or surveillance over large areas and Unmanned Free Balloons (UFB), as well as manned sub-orbital flights for leisure or scientific purposes (e.g. experiments, films or tourism at zero gravity) and supersonic or hyper-sonic passenger aircraft. This volume of airspace will, therefore, be used by all classes of air vehicle, from static, barely manoeuvrable unmanned balloons, through high-speed passenger aircraft to rapidly-climbing rockets.

Although State and commercial space launchers will transit this volume of airspace, space operations, or 'space traffic control', are not in the scope of this topic. However, research should reflect that higher airspace is capable of allowing such operations to proceed without undue hindrance to them, and without adversely affecting the safety of higher-airspace vehicles.

The management of higher airspace is only just being considered by ICAO, and even its vertical boundaries are, as yet, undefined. The exploitation of space is a politically very sensitive issue and so research into this topic, at the boundary with space, should consider, inter alia, political sensitivities, operational concepts and CNS issues, while performing a thorough, global analysis of operational and business needs.

Proposals need to plan effort for:

- Ad-hoc participation in the European Commission New Entries working group.
- Developing the European Concept of Operations for Higher-Airspace operations, or supporting its development if such an initiative has already commenced in the context of the European Commission New Entries working group.
- Addressing the link with the European ATM Mater Plan and the SESAR Concept of Operations.

Proposals addressing this application area must plan the following milestones:

- A public deliverable should be delivered to the SJU 12 months after the start of the project describing the current global demand for higher-airspace operations, how States and businesses are addressing it, and their interface with space agencies and operations, with the aim of generating a detailed picture of demand, barriers, opportunities and possibilities. This deliverable should be presented in a public event with the objective of collecting feedback on how this demand can be best addressed.
- A public deliverable with the report of the project's analysis of the feedback collected during the event with recommendations for further work in the area should be delivered 14 months after the start of the project.
- The work in the last ten months of the research activities should be focused on developing or supporting the development of the European Concept of Operations for Higher-Airspace operations, potentially including in-depth concept development to address one or more of the challenges that are specific to high-level operations.

Higher Airspace Operations	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V0	V1

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	Not applicable
	Interoperability	The solution will contribute to the development of Concept of Operations for Higher-Airspace operations at European level.
	Sharing of infrastructure	Not applicable
	Scalability	Not applicable
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The solution improves access and equity to the 'New Entrants' while not adversely affecting the safety of higher-airspace vehicles.
Deployment oriented outcome		This volume of airspace will, therefore, be used by all classes of air vehicle, from static, barely manoeuvrable unmanned balloons, through high-speed passenger aircraft to rapidly-climbing rockets

Relevant links to the ATM Master Plan Level 2 (DS19p):

Higher airspace operations was not defined at the time the ATM Master Plan 2015 was endorsed. The solution contributes to the ATM Master Plan 2020 EOC "Multimodal mobility and integration of all airspace users".

This new SESAR Solution needs to be created together with the required enablers for future datasets.

3.4 SESAR-WAVE3-04-2020 Topic "Enhanced automated air/ground synchronisation"

3.4.1 Problem statement and R&D needs

In the area of voice communications, the current controller-pilot voice communications concept of operations is a de facto result of the way of working and the performance of the legacy system (i.e. the analogue DSB-AM VHF radio system). In the area of controller-pilot communications via datalink, the current CPDLC is applicable only above FL285. The SESAR concept considers an evolution towards digital voice channels and to an increase use of CPDLC, including its extension below FL285.

The automatic sharing of data between the airborne systems and the ATM ground systems in the Industrial Research programme is limited to what is possible with the ATN B2 standard; it includes the downlink of the Extended Projected Profile (EPP) and the interrogation/reply related to the ETA min/max window over a waypoint, as well as the data that are downlinked via SSR Mode-S. The evolution from ATN B2 and current Mode-S will further extend the scope of automatic air/ground data exchange.

The increased connectivity between air and ground required to support the future concept will be realised in a multilink environment, according to the Master Plan principles of service-orientation and scalability, of which the future air-ground terrestrial datalink (LDACS) is a key element, which will support also the resilience of aircraft navigation. LDACS is under research in SESAR2020 Wave 2 solutions PJ.14-W2-60 and PJ.14-W2-81. The SJU has identified a risk for the achievement of the target maturity at the end of Wave 2. This Wave 3 topic aims at mitigating this risk by complementing the Wave 2 solutions.

3.4.2 Performance expectations

The solutions to be developed under this topic are expected to provide:

- The solution is a required enabler for the TBO concept providing the demanded capacity for 2035;
- The objective is to increase A/G connectivity, and avoid that traffic growth is blocked due to the lack of availability of VHF frequencies. The solution provides the technical support to the other two solutions in this topic.

3.4.3 SESAR Solutions

3.4.3.1 Solution PJ.35-W3-01 L-DACS complement

L-DACS (L-band Digital Aeronautical Communications System) is a multi-application cellular broadband system capable of simultaneously providing various kinds of Air Traffic Services (including ATN B3) and Aeronautical Operational Control (AOC) communications services in all environments. L-DACS is optimized for data link communications, and is also able to support aircraft navigation

This Wave 3 solution shall cover two threads:

- **Thread 1**: covers complementary activities to de-risk the maturity expectations at the end of Wave 2 on COM and NAV aspects of LDACS under PJ.14-W2-60 and PJ.14-W2-81;
- **Thread 2**: covers the development of digital voice beyond flight-centric operations, in close coordination with the Wave 3 solution "Enhanced operations through advanced digital voice and datalink controller/pilot communications" that develops the controller-pilot

communication ConOps, which will supply the operational requirements. This thread contributes to address an R&D gap identified in the AAS.

Thread 1: Complement to PJ.14-W2-60 FCI Terrestrial Data Link and A-PNT enabler (L-DACS) and to PJ.14-W2-84c Alternative Positioning, Navigation and Timing – LDACS Analysis.

Complementarity:

This thread main objective is to plan and execute the required activities to mitigate the risks in Wave 2 solutions PJ.14-W2-60 and PJ.14-W2-81c to achieve the expected target maturity at the end of Wave 2. In particular the proposal shall address:

- Definition, planning, execution of flight tests and analysis of results in order to secure the TRL6 achievement of FCI Terrestrial Data Link (L-DACS) communication part (PJ.14-W2-60). The flight trials will validate L-DACS support to different potential applications (ATN-B1, ATN B2, AOC) by involving TRL6 prototypes both for avionics and ground systems.;

- Development, verification and integration of the required prototypes to secure the TRL4 for Solution PJ.14-W2-81c "Alternative Position, Navigation and Timing (A-PNT) - LDACS analysis". These prototypes shall be capable of supporting the technical validation of the A-PNT requirements as identified by PJ.14-W2-81c and shall contribute to the feasibility assessment of A-PNT in cooperation with PJ.14-W2-81c.

Thread 2: L-DACS Voice

The L-DACS system will support point-to-point full-duplex A/G communications, but this aspect has not reached the expected maturity in Wave 1 (under PJ.14-02-01). In Wave 2, the development of the L-DACS digital voice service is planned under solution PJ.14-W2-77, but the scope is limited to the support flight-centric operations. This thread aims at the development of the LDACS voice concept for all operational environments. The ultimate goal is to completely substitute the use of VHF radio in controller-pilot communications.

Complementarity:

This solution supports the geographically independent controller-pilot communications, as required by the target concept described in the Airspace Architecture Study (AAS) e.g. section D.4.7. It will increase A/G connectivity and avoid that traffic growth be blocked due to the lack of availability of VHF frequencies, and also support the virtualisation of ATS services and the move to a service-oriented architecture. The solution should also bring an increase of the level of security compared to current operations, e.g. by using technical means to identify where a transmission comes from for authentication purposes.

LDACS voice must be developed to work in a multilink environment, where different digital voice airborne users may be connected to the ground though different communication means, e.g. AeroMACS, and potentially in the future SATCOM LEO voice services. Due to the laws of physics (geostationary latency), SATCOM GEO can't substitute VHF radio. The multilink environment will also include the ground-ground routing of the communications between RPAS pilots and ATC.

This solution complements the work in Wave 2 and shall:

- Develop and assess potential architectural options to support digital voice services;

- Discussion of potential protocols for the transmission of digital voice and justification of choice of protocol;
- Elaborate an initial set of functional requirements;
- Perform initial safety and security assessments.

This solution shall closely coordinate with all PJ.14 Wave 2 solutions in order to ensure a coherent approach.

In Wave 1, only digital voice applications in support of flight –centric ATC were considered. The scope in Wave 2 and Wave 3 is broader. Digital voice is foreseen to completely substitute VHF radio in the long term, in all continental operational environments: en-route (flight-centric or with geographic sectors, continental high and low density), TMA and TWR, including ground and platform control.

The baseline operational requirements for the digital voice service for this solution are those proposed in the Communications Operating Concept and Requirements for the Future Radio System (COCR) Document 2.0, which consider digital voice channels with party-line; maximum latency requirements for each of the operational environments defined in section 5.1 of the document. User acceptability and intelligibility must also be considered.

The COCR 2.0 was a widely consulted document; any deviation of the COCR 2.0 performance requirements needs to be justified by a consultation process though expert groups including representation from both airborne and ground operational and technical stakeholders (AUs, airborne industry, ANSPs, ground industry, CNS industry and EUROCONTROL).

In addition to the COCR 2.0 requirements, the concept must also consider the feasibility of making the handover of an airborne user from one voice channel to the next voice channel to be transparent to the airborne user and linked to the datalink handover, as per the "single connection to ATC" concept.

A key aspect of the business case for the move to digital voice is the potential freeing of VHF spectrum in the long term. In order to make this possible, it is essential to be able to ensure availability of air to ground communication via voice without VHF. The LDACS voice solution must provide characterization of the availability of the LDACS digital voice service in comparison with the availability of the legacy VHF voice service.

This complementary solution will contribute to the LDACS aspects of the CBA in Wave 2 in solutions PJ.14-W2-60 and PJ.14-W2-81c. Given that LDACS involves cost for new equipage, it is essential that sufficient resources be allocated to the CBA contributions of the two threads of this complementary solution from an early stage. It is expected that this Wave 3 complementary solution contributes in particular with a comprehensive analysis of the benefits of moving to digital voice.

This Wave 3 solution must take the lead for the quantification of the following benefits for the CBA:

- Benefit of avoiding that lack of availability of VHF frequencies prevents traffic growth in the medium term. For this aspect, it is recommended that a study of the outlook in terms of unavailability of VHF frequencies and corresponding blockage of traffic growth be conducted in support of the CBA. Ongoing activities in the area of VHF spectrum availability in solution PJ.10-W2-73 should be considered.
- Contribution of digital voice to virtualisation of air-traffic services and service orientation. For this aspect, business models should be analysed.

- Estimation of the reduction of ATCO and pilot workload enabled by the "single connection to ATC" concept, e.g. by quantifying reduction in number of VHF communications. Given that this is a technical solution where there may be no possibility to run simulations to measure this workload reduction, this estimation can be based on a literature review to provide an estimation of the part of the workload of ATCOs and pilots that corresponds to handover communications. Input can also be taken from the ongoing studies in PJ.10-W2-73, where VHF handover communications are eliminated, but only for the flight-centric environments and while the flight remains under the control of the same controller. Note that digital voice will allow an extension of this benefit for all environments, where no "change of frequency" action will be required on the side of the flight crew, even when the flight is handed over from one ATCO to another ATCO or even between ATCOs located in different ATSUs, including from/to TWR to/from TMA and from/to TMA to/from en-route.

- Potential benefits of the use of LDACS for flight-deck to AOC voice communications, or benefits of freeing VDL2 for AOC communications traffic thanks to the move of ATC communications traffic to LDACS voice.

- In the long-term, potential for freeing VHF spectrum currently allocated to ATC for other aeronautical use, e.g. drones, future LEO ATM constellations for communications and/or ADS-B and evolution to future contract-based surveillance (as per the output of SESAR ER project SALSA), etc.

Expected benefits:

L-DACS provides the required reliable, scalable, modular and efficient data link technology to support 4D trajectory management operational concept needs. L-DACS also constitutes a potential component of the A-PNT to support positioning and navigation requirements in PBN/RNP operations in case of a GNSS degradation or outage.

The SESAR solution will contribute, in close collaboration with the aforementioned PJ.14-W2 solutions, to:

- Provide a data-link capability able to deal with the increased communications needs in support of the expected traffic growth.

- Support future operational concepts requiring more stringent technical A/G datalink communication performance (reduced latency compared to current datalink).

- Improve the resilience of GNSS, and potential contribution to the rationalization of the CNS infrastructure (spectrum efficiency).

- Contribute to the virtualisation of ATC services through the geographically independent communications concept enabled by the digital voice service.

Coordination between Wave 2 and Wave 3 Projects

For thread 1, the Wave 3 activities should directly contribute to the solution data packs to be delivered by the solutions PJ.14-W2-60 and PJ.14-W2-81c. The SESAR 2020 Wave 2 PJ.14 project that has started on January 2020 will elaborate the initial version of the data pack taking into account the results and recommendations of past validation and demonstration activities, in particular PJ.14-02-01, PJ.14-02-04 and PJ.14-03-04. Wave 3 activities will deliver:

- Required availability notes to document the results of verification and integration activities of the prototypes developed under Wave 3 scope;
- Technical validation exercise plans and reports feeding the TVALP and TVALR in Wave 2 solutions.
- White paper with quantification of LDACs benefits specific to digital voice and LDACS for A-PNT. This white paper will be an input for the PJ.14-W2-60 and PJ.14-W2-81c CBAs.

The final version of the solution data pack will be jointly elaborated by a close cooperation between Wave 2 and Wave 3 project teams. For thread 2, a full TRL4 solution data pack is required given that these activities are not covered by Wave 2 solutions.

FCI Terrestrial Data Link (L-DACS)	MATURITY LEVELS (in support of PJ.14-W2-60)	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	TRL4	TRL6
Alternative Positioning, Navigation and Timing – L-DACS	MATURITY LEVELS (in support of PJ.14-W2-81)	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	TRL2	TRL4
L-DACS Voice	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	TRL2	TRL4

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	The solution promotes a common service architecture across the European ATM system.
	Interoperability	The solution enables the seamless exchange of information between systems.
	Sharing of infrastructure	N/A
	Scalability	LDACS voice is an enabler for a European wide deployment of the AAS Virtual Centre concept, thus contributing to the scalability of ATC services.
Increase network performance (capacity, environment) and/or better		The objective is to increase the capacity, reliability and flexibility of A/G connectivity. It will avoid that traffic

access to airports including regional/secondary airports	growth is blocked due to the lack of availability of VHF frequencies and eases remote and flexible provision of ATC services through the AAS virtual Centres concept. The solution provides the technical support to the other two solutions in this topic.
Deployment oriented outcome	The solution supports the automation and digitalisation concepts in support of the Airspace Architecture Study (AAS).

Relevant links to the ATM Master Plan Level 2 (DS19p):

The scope under this solution is a required enabler to support the Key R&D need identified in the ATM Master Plan 2015 "Future communications infrastructure (FCI) terrestrial datalink" and contributes to the ATM Master Plan EOC "CNS infrastructure and services".

This SESAR Solution complements the work performed by solution PJ.14-W2-60 and PJ.14-W2-81c.

As a consequence of the potential re-scope of the CTE-C01b digital voice enabler proposed at the end of Wave 1 for it to be focused on point-to-point digital voice, the SJU has identified the potential need to create a new digital voice enabler to cover the broadcast/voice channels option.

3.5 SESAR-WAVE3-05-2020 Topic "Collaborative management of TMA & Airport throughput"

3.5.1 Problem statement and R&D needs

The current ATM environment based on static flight plans is evolving towards a trajectory based environment in order to improve airports and ATM network performance. Airspace users' (AU) 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 into the requested trajectory, and respect any constraint in a way that best meets the business priorities. Today the ATM system allows little flexibility to airspace users (e.g. ATFM slot swapping process). Airspace users' full participation through their flight operations centres (FOC/WOC) into ATM collaborative processes, including flights' prioritisation with the full user driven prioritisation process (UDPP), is essential to minimise impacts of deteriorated operations for all stakeholders including airspace users. A better recovery process that should offer more flexibility to accommodate AUs' changing business priorities and equity in the ATM system. The collaborative planning and flight execution processes shall be performed at 'level playing field', i.e. performance of all actors is taken into consideration. Rules must be implemented in case no collaborative planning is possible.

Complex interacting traffic flows in the TMA (including from/to multiple airports) need to be more actively managed to increase safety and improve fuel efficiency whilst capacity is increased. Continuous climb and continuous descent operations (CCO/CDO) at near idle thrust are environmentally friendly, because they are more fuel efficient and also minimize the time that aircraft have to be at low altitude, thereby reducing their noise impact. However, controllers often need to use intermediate level-offs in order to ensure separation. 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 Air Traffic Control (ATC) task. Multiple arrival management systems need to ensure a more regular flow of arriving aircraft managed for TMA optimisation as well as runway optimisation. Multiple departure management systems are required to enable a more consistent delivery of departures into the TMA and ultimately to En-Route sectors. Improved flows will help to facilitate optimised profiles for aircraft, with dynamic route structures able to provide additional solutions integrated with the management of queues.

3.5.2 Performance expectations

This topic will develop solutions that are expected to have a positive impact on the Network improving:

- Increased capacity based on a better integration of the AUs trajectory definition and the network demand and capacity function;
- Airspace capacity (improved throughput / airspace volume & time) and airport capacity (improved runway throughput flights/hour) thanks to the synchronisation of the arrival and departure sequences to and from airports using extended AMAN overlapping operations;
- Increased flexibility by allowing the airspace users to recommend to the network management function a priority order for flights;
- Environmental sustainability - fuel efficiency thanks to the use of the preferred trajectory taking into consideration the Airspace users' needs and the implementation of continuous descent and climb profiles;
- Increased punctuality and predictability of individual flights thanks to the collaborative framework of the trajectory management.
- Cost-efficiency (reduced direct ANS cost per flight).

3.5.3 SESAR Solutions

3.5.3.1 Solution PJ.36-W3-01 Complement of PJ.07-W2-39 Collaborative framework managing delay constraints on arrivals

The main objective of solution PJ.07-W3-39, as proposed in Wave 2, is to define and validate a collaborative framework for the coordination and collaboration between different ATM processes (including the so-called User Driven Prioritisation Process - UDPP[1]), dealing with delay constraints on arrivals (considered the most important contributor to performance issues).

This collaborative framework shall enable the coordination and integration of 4D trajectory constraints for various stakeholders (Airports, ANSPs, AUs and Network Manager) in order to ensure the continued stability and performance of the ATM network, at regional and local level, while taking into account the AU business needs.

[1] *The User Driven Prioritisation Process UDPP is a service to AUs designed for any type of delay constraint resulting from capacity issues in the Network, to help reduce the financial impact of delays on AUs operations. It has been defined with dispatchers and OCC OPS supervisors to be equitable by design: no prioritisation made by one AU on its flights can have a detrimental impact on the flights of another AU.*

This solution shall address the following objectives:

- Reconcile disparate local initiatives developed for managing arrival delay constraints;
- Offer to Airspace Users a single harmonized entry point through Network Manager to manage their priorities;
- Support further integration of Network/Airport processes, beyond the current AOP/NOP integration, mainly relying on simple data exchanges;
- Address remaining issues and gaps identified by SESAR Wave 1 PJ.24 and PJ.25 regarding arrival priorities;
- Address the need for harmonization and interoperability at European level.

PJ.07-W3-39 shall consider the results and recommendations related to Target Time management stemming from SESAR 1 and SESAR 2020 Wave 1 projects, in particular SESAR 2020 Wave 1 PJ.07-02, PJ.09-02 and PJ.09-03, PJ.04-01 and PJ.04-02, PJ.24 and PJ.25 live trials.

Complementarity:

In SESAR 2020 Wave 1, different approaches and use cases for the management of arrival constraints have been defined and validated using specific local tools.

SESAR 1 Solution #18 "CTOT and TTA" validated the concept of Target Time Management in the planning phase from a network perspective, and SESAR 1 solutions #20 "Initial Collaborative Network Operations Plan (NOP)" and #21 "Airport operations plan (AOP) and its seamless integration with the network operations plan (NOP)" validated the process for local DCB actors to collaborate with the network in TTA allocation; PJ.24 demonstration exercises at Barcelona, Palma and Heathrow airports addressed hotspot resolution based on TTA proposed for arriving flights in the pre-flight phase by local DCB tools using local business rules. The TTs were defined at local level in close cooperation between airports and airlines and shared with the Network Manager via the AOP connected to the NOP through SWIM (B2B web services).

In the frame of SESAR 2020 Wave 2 PJ.07-W2-39, several exercises addressing the reconciliation of the local initiatives are planned at Barcelona, Palma, Zurich and Heathrow airports, with a particular focus on local DCB and airport processes. The objective of this complementary activity is to build on PJ.25 EXE-VLD-07-003 results, where a collaborative decision process between local DCB and AUs to establish the optimal TTA sequence was developed. The process allowed an improved TTA allocation process though the use of the iAMAN tool, which applies an AMAN-like logic to TTA allocation that provides more refined TTA allocation proposals than the traditional CASA-based process, e.g. by considering arrival route in combination with arrival time. The process allowed AU to provide ATC with modification requests concerning the calculated arrival sequences, and allowed TTA allocation to accommodate user preferences (while respecting the principle of equity). This process concerns TTA allocation (i.e. before CTOT allocation) rather than AMAN planned time allocation

The exercise demonstrated how TTA allocation and AU preferences could be combined:

- Reducing to the minimum the impact of a flight (prioritisation of «sensitive» flights by at the detriment of less important flights for the airspace user).
- Exchange of slots between two regulated flights (SWAP).

- Departure before EOBT.
- Collaborative cherry picking (MCP in collaboration with Airspace users).

The Wave 3 complementary activity should investigate improvements to the AFLEX – iAMAN process, and ensure that their scope is adequately covered in the ATM Master Plan, as well as formalize the requirements of the improvements demonstrated by PJ.25. This will include in particular the creation of the corresponding OIs and Enablers.

The AFLEX-iAMAN processes do not directly modify the E-AMAN systems and do not affect the way controllers build or manage the arrival sequence; nevertheless, arrival management is improved because the improved DCB processes also improved traffic presentation, which is the input used by E-AMAN for building the arrival sequence. The complementary activity may continue to limit its scope to the planning phase/TT allocation or extend the scope to include changes to the arrival management processes.

Expected benefits

- Expected benefits include a better integration of AUs in ATM decision making processes and optimal planning of scarce ATM resources, which should lead to increased predictability by sharing up-to-date flight information and improved AU schedule management by minimizing the impact of reactionary delays, thereby contributing to flight-efficiency and AU cost-efficiency.
- Automating much of the coordination and analysis of options with local tools that contain AU preferences and connect to the network systems through SWIM should also increase productivity of local FMPs and network operations staff, thereby contributing to ANSP and NM cost-efficiency.

Coordination between Wave 2 and Wave 3 Projects

The Wave 3 activities should directly contribute to the solution data pack to be delivered for the solution PJ.07-W2-39. The SESAR 2020 Wave 2 PJ.07 project starting on January 2020 will elaborate the initial version of the data pack taking into account the results and recommendations of past validation and demonstration activities, in particular PJ.25 exercises at CDG. Wave 2 validation exercises are scheduled in 2021 and 2022, which does fit with the foreseen Wave 3 execution time frame. Wave 3 activities will deliver a specific exercise plan and report feeding the solution VALP and VALR. The final version of the solution data pack will be jointly elaborated by a close cooperation between Wave 2 and Wave 3 project teams.

The participation of Airspace Users will be ensured through a call for tenders to be issued by EUROCONTROL.

Collaborative framework managing delay constraints on arrivals	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V3 on-going	V3

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

<table>
<tr><th colspan="2">Principles</th><th>How does the solution contribute to these principles?</th></tr>
<tr><td rowspan="4">Added value for the ATM network</td><td>Defragmentation of service provision</td><td>N/A</td></tr>
<tr><td>Interoperability</td><td>The solution addresses the need for harmonization at European level of arrival prioritisation processes. The solution will strongly improve interoperability as the result of the increased common situation awareness for all concerned stakeholders: sharing network situation including DCB constraints and opportunities, provision and sharing of flights' priorities from AUs for an agreed process and set of measures resolving Local Demand/Capacity imbalances on arrivals.</td></tr>
<tr><td>Sharing of infrastructure</td><td>N/A</td></tr>
<tr><td>Scalability</td><td>The solution focuses on more integrated Network/Airport processes, beyond the current AOP/NOP integration that relies on simple data exchange.</td></tr>
<tr><td colspan="2">Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports</td><td>The solution will contribute to improve network capacity by providing AUs, Flow Managers and Airport Operators with means to better exploit opportunities and use available capacity. The Solution will also contribute to minimize the financial impact of capacity constraints on AUs.</td></tr>
<tr><td colspan="2">Deployment oriented outcome</td><td>The solution contributes to complete the V3 maturity level for solution PJ.07-W2-39 and thus transition for industrialization and deployment.</td></tr>
</table>

<u>Relevant links to the ATM Master Plan Level 2 (DS19p):</u>

The scope under this solution contributes to complete the Key R&D needs identified in the ATM Master Plan 2015 "Airspace user fleet prioritization and preferences" and "Airspace user processes for trajectory definition and airspace user trajectory execution from flight operations centre (FOC)" and contributes to the ATM Master Plan 2020 EOC "ATM interconnected Network".

This SESAR Solution complements the work performed by solution PJ.07-W2-39 (that follows up SESAR Solutions PJ.07-01 and PJ.07-02 in Wave 1 and initially contribute to complete the list of OI steps under the scope of Wave 2 solution. It is anticipated that new OIs and Enablers will be required to cover the concepts that are currently not well represented in the Master Plan level 3; this applies in particular to the iAMAN concept.

3.5.3.2 Solution PJ.36-W3-02 Complement of PJ.01-W2-08 Dynamic E-TMA for Advanced Continuous Climb and Descent Operations and improved Arrival and Departure Operations

Continuous Climb Operations (CCO) at optimum thrust and Continuous Descent Operations (CDO) at near idle thrust are environmentally friendly, because they are more fuel efficient and also minimize the time that aircraft have to be at low altitude, thereby reducing their noise impact. However, controllers often need to use intermediate level-offs in order to ensure separation. The objective of this solution is to improve descent and climb profiles in busy airspace (as close as possible to near idle CDOs and optimised CCOs), as well as the horizontal flight efficiency of arrivals and departures, while at the same time ensuring traffic synchronization (for optimum use of runway capacity), short-term DCB (to ensure best use of ATC capacity) and separation. This challenging objective requires a very broad scope, which includes advances in airspace design, development of ground and airborne tools, and development of ATC and airborne procedures.

Complementarity:

Wave 3 activities shall address:

- Additional work on SYSMAN beyond what is covered by Thread B4 – Traffic Optimization within the TMA in Wave 2 in solution PJ.01-W2-08, with a focus on how the management of systemised airspace for departures can contribute to A-CCO (AOM-0705-B). This would help to mitigate against both the issue that departure management aspects of SYSMAN were not fully addressed in Wave 1 PJ.01-02 and the Wave 2 risk 'Coverage of OI AOM-0705-B'. Wave 3 solution shall:
    - Identify operational requirements to further develop the SYSMAN tool;
    - Conduct the required verification activities;
    - Execute validation activities, providing performance data and further confidence at V2 level to enhance the existing planned work in Wave 2.
- Activities across PJ.01-W2-08 and PJ.18-W2-56 by doing some work on Improved vertical profiles through enhanced vertical clearances, building on the already planned work in Thread B1 - Descent Phase Support in PJ.01-W2-08 in Wave 2 to develop requirements for longitudinal Conformance Monitoring for sequencing.
- Further strengthen Solution PJ.01-W2-08 Thread A1 (Short-term DCB Optimization of TMA and E-TMA Airspace with TMA Management Tools) with departures aspects, providing mitigation by filling in gaps from Wave 1 to address the Wave 2 risks 'Wave 1 Maturity Assumption' and 'PJ.01-W2-08A maturity may not achieve full V3'. This specifically relates to mitigating against any remaining gaps from Wave 1 in the OI steps TS-0307 (Integrated Arrival Departure Management for Traffic Optimisation within the TMA) and TS-0302 (Departure Management from Multiple Airports).

Expected benefits

- Environmental benefits.

Coordination between Wave 2 and Wave 3 Projects

The Wave 3 activities should directly contribute to the solution data pack to be delivered for the SESAR 2020 Wave 2 solution PJ.01-W2-08a and PJ.01-W2-08b. The Wave 3 activities will deliver a specific exercise plan and report feeding the Wave 2 solution VALP and VALR. The final version of the solution data pack will be jointly elaborated by a close cooperation between Wave 2 and Wave 3 project teams.

Digital synchronisation of arrivals and departures	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V2	V3
Dynamic TMA/E-TMA for Advanced Continuous Climb and Descent Operations	MATURITY LEVELS	
	Maturity Level at the start of Wave 3	Target Maturity Level at the end of Wave 3
	V2 on-going	V2

The solution contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	N/A
	Interoperability	Thread B4 in PJ.01-W2-08 (complemented by this Wave 3 solution) focuses on airspace capacity management for systemized airspace. The solution brings together information, which currently resides in a number of separate systems thus improving interoperability.
	Sharing of infrastructure	N/A
	Scalability	N/A
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		Airspace Capacity and throughput will be improved: • By a better balance of existing capacity and by avoiding overloaded sectors or in approach leading to smaller sector dwell times in E-TMA and TMA (less usage of or shorter trombones); • Through early adjustments of flight speed to achieve the AMAN constraint before reaching Top of Descent thereby reducing tactical intervention in approach to fine adjustments before final approach; Through reducing bunching to enable a new systemized airspace structure in a high

	density/complexity environment with less tactical intervention needed in the TMA / E-TMA airspace. Environmental efficiency will be increase: • By a better management of the arrival flows via sector load balancing in the E-TMA resulting in shorter routes and slower aircraft speeds when delay needs to be absorbed; • Through the facilitation of Continuous Descent Operations, and closed loop PBN based approach paths; • Through the facilitation of Continuous Descent Operations, reduced low-level holding and descent speed support in a systemized environment.
Deployment oriented outcome	The solution contributes to complete the V3 maturity level for solution PJ.01-W2-08 and thus transition for industrialization and deployment

Relevant links to the ATM Master Plan Level 2 (DS19p):

The scope under this solution contributes to complete the Key R&D need identified in the ATM Master Plan 2015 “Use of arrival and departure management information for traffic optimisation within the TMA” and to the additional R&D need “Extended AMAN with overlapping AMAN operations and interaction with DCB” and contributes to the ATM Master Plan 2020 EOC “Airport and TMA performance”.

This SESAR Solution complements the work performed by solution PJ.01-W2-08 (that follows up SESAR Solutions #01-02 and #01-03B in Wave 1) and covers the following OI steps:

- AOM-0702-B — Advanced Continuous Descent Operations.
- AOM-0705-B — Advanced Continuous Climb Operations.
- AOM-0806 — Dynamic Management of Terminal Airspace Routes and Transition.
- TS-0302 - Departure Management from Multiple Airports.
- TS-0307 - Integrated Arrival Departure Management for traffic optimisation within the TMA and Extended TMA Airspace.

These OI steps may need to be updated (or new ones may need to be added) in future datasets in coordination with PJ.01-W2-08.

3.6 SESAR-WAVE3-06-2020 Topic "Integrated Runway Throughput and Terminal Efficiency"

The demonstration activity addresses, in preparation for deployment, the integration of a series of individually validated solutions in SESAR 1 and SESAR 2020 Wave 1 contributing to increasing runway throughput, environmental sustainability and terminal airspace efficiency.

Research in SESAR 1 and SESAR 2020 Wave 1 has validated TMA and Runway solutions in different projects, but these components (see below the list of relevant OI steps and SESAR solutions) have been independently matured. As the different solutions have been independently validated they are likely to be sub-optimal when considering the performance of the whole arrival/departure value chain. Integrated procedures, requirements and safety cases are required to cover the transition from TMA, Final Approach to landing for the independent solutions in preparation for deployment.

This VLD represents an opportunity to operationally integrate the related procedures and validate the ensemble of the following SESAR solutions:

- Arrival Management metering - SESAR 1 Solution #05 (TS-0305-A - "Arrival Management Extended to En-Route Airspace - single TMA"). The AMAN horizon is extended to the En-Route airspace further from the TMA and may extend across several En-Route sectors, potentially including across borders, requiring an increased degree of cross-border co-operation and support from "distant" ATM actors to resolve problems for an airport far outside their normal sphere of operations. The across border aspect is key to un-lock benefits and involve cooperation between different actors / ANSPs;

- Application of RNP capability and route structure such as point merge and trombone to enable progressive implementation of continuous descent operations (CDO) ideally from top of descent (ToD) and in high density operations – (e.g. SESAR 1 Solution #11, solution PJ.01-03B) with quantification of fuel consumption and noise benefits;

- Time Based Separation - SESAR 1 Solution #64 (AO-0303 "Time Based Separation for Final Approach - full concept") with advisories extending out onto Point Merge arc and RNP route, and Pairwise wake separation minima - Wave 1 Solution PJ.02-01 (AO-0306 "Wake Turbulence Separations for Arrivals, based on Static Aircraft Characteristics" - RECAT-PWS-EU). Benefits are predictable separation delivery, reduced go around numbers and reduced under spacing with increased capacity of up to 12% depending on traffic mix;

- Interval Management (IM) is a solution that improves the precision and consistency of inter-aircraft spacing - Wave 1 Solution PJ.01-05 (TS-0108). The precise spacing allows simultaneously achieving high arrival capacity and predictability while enabling aircraft to operate on fixed PBN routes in the TMA (aka RNAV/RNP Transitions) with a fixed profile descent (FPD), which enable more continuous descents, resulting in decreased fuel burn and noise impact. The solution is also a step towards less complex TMA operations, strategic de-confliction of inbound and outbound traffic, and trajectory-based operations (TBO). Quantified benefits are an increase in landing runway throughput of up to 14% and, aggregated at ECAC level, a 12.5 kg (0.26%) fuel reduction per flight.

- Departure tools support for departure pairwise separations aligning with the Airport Operations Plan (AOP) and the Network Operations Plan (NOP) and provide more predictable and therefore more efficient use of airspace in the TMA and en-route thus working toward enhanced airport integration. Such tools integrate non-wake separation constraints on departures. With the development of the ATC tool support for optimising departure traffic, the opportunity arises to also consider more refinement in non-wake separations by incorporating information/parameters from the TMA within this toolkit. An initial study is proposed to understand the variables/parameters of the TMA that would be needed for such a toolkit.

Operational Scenario:

- Extended Arrival Management (from 300 to 150 NM from the expected runway) adjusts the number of aircraft according to cumulated runway predicted throughput. Aircraft may adjust its 4D trajectory to respect a Target Time or have a speed reduction from ATC;
- Arrival Management (from 150 to 50 NM from touchdown) allocates the runway, calculates the allocated runway ETA and runway sequence, considering the predicted runway throughput, traffic mix, IM capabilities of aircraft (reduced separation buffer) and RECAT-PWS-EU separation criteria for optimization. Aircraft may adjust its 4D trajectory to respect a Target Time if so instructed by ATC, or alternatively receive an ATC instruction to adjust speed; TBS is advised of the sequence considering the aircraft position at 50 NM from threshold. An optimal vertical profile is defined for the procedure and speed adjustments are limited to ensure the vertical profile remains optimum;
- Time Based Separations (TBS) advisories or proposed Interval Management clearances will extend out along the APP RNP routes;
- The procedures are defined to manage an optimal trajectory and final approach. Aircraft may adjust its 4D trajectory to respect a Target Time or have a speed reduction from ATC based on a TBS advisory or have FIM equipped aircraft adjust their speeds without ATC intervention;
- The aircraft joins the agreed RNP procedure like Point Merge that optimises the trajectory and the merging at the Final Approach Fix (FAP) to respect the best time separation at threshold. TBS advises turn to the merge point, together with any altitude/speed instructions (as applicable); TBS/ORD AO-0328 advisories continue to ensure final approach separation is ensured with further speed instructions to maintain the separation and deal with compression effect;
- Controllers operate in a systemised manner according to the defined procedures, which should limit number of instructions;
- Departure tools integrate non-wake separations, departure sequence and ensure alignment on AOP/NOP.

The proposal shall:

- Develop an integrated concept of operations and develop the associated operational procedures and define the necessary system support, taking into account the maturity of the individual concept elements;
- Undertake integrated validations and/or demonstrations (ranging from real-time simulations to live trials with industrial prototypes depending on the maturity of the elements being integrated) on 2 to 3 different operational environments to validate the integrated TMA and runway throughput solutions;

- Consolidate the results, update operational requirements, associated guidance material and a generic safety case together with complementary contextual Runway and TMA deployment scenarios and benefits cases;

- Develop the necessary technical requirements to complement the operational requirements.

This VLD may require the contribution from Airspace Users (AUs) who are not members of the SESAR JU. It is expected that the SESAR JU members will subcontract the required AU contribution (the VLD open call is not intended to complement the VLDs in this Wave 3 IR VLD call).

As expected in the applicable template, the demonstration report (DEMOR) shall clearly document any feedback / update related to the operational / technical requirements available in the datapacks from those solutions under the scope of the VLD. In case the demonstration project covers new solutions that have not been researched in SESAR yet, the DEMOR shall include the relevant operational and technical requirements that would be needed for the eventual industrialization and deployment of these new solutions. The project shall ensure that the information in the ATM master plan related to the scope of the VLD (e.g. SESAR Solution, OI steps, enablers) is keep up to date and reflect the results obtained by the project.

The demonstration contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	N/A
	Interoperability	N/A
	Sharing of infrastructure	N/A
	Scalability	The demonstration addresses the integration of different solutions in different type of airports allowing defining guidelines for the deployment of the best possible combinations of SESAR solutions depending on the local airport needs.
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		The solutions under the scope of the demonstration contribute to increase runway throughput in congested airports allowing alleviating capacity bottlenecks in the European network.
Deployment oriented outcome		The demonstration contributes to accelerate transition into deployment of AF-1 and AF-2 related functionalities (Essential operational changes “Time-based separation (TBS) for final approach”, “Arrival management extended to en-route airspace (E-AMAN) and “Enhanced terminal airspace using RNP-based operations”)

Relevant links to the ATM Master Plan Level 2 (DS19p):

This demonstration covers solutions that address the Key R&D need identified in the ATM Master Plan 2015 “Wake turbulence separation optimisation”. It also covers the additional R&D need “Airborne Spacing Flight Deck Interval Management”. The demonstration also contributes to accelerate transition into deployment of AF-1 and AF-2 related functionalities (Essential operational changes “Time-based separation (TBS) for final approach”, “Arrival management extended to en-route airspace (E-AMAN) and “Enhanced terminal airspace using RNP-based operations”). The VLD contributes to ATM Master Plan 2020 EOC “Airport and TMA performance”.

The relevant SESAR solutions are #9, #51, #11, #64 and #05 from SESAR 1 and PJ.02-01 and PJ.01-05 from SESAR 2020 Wave 1.

3.7 SESAR-WAVE3-07-2020 Topic "Downlinking Flight Trajectory for improved ATM performance"

This VLD will continue the work performed by projects PEGASE (SESAR 1) and DIGITS/DIGITS-AU (SESAR 2020 Wave 1/OPEN VLDs 1) to demonstrate the ATM benefits from further usage of ADS-C reports, including EPP data, that are downlinked from aircraft operating routine revenue (airline) flights across Europe to the ground systems.

In Wave 3, the objectives of this demonstration would be to:

- Complete the progressive integration of more ADS-C data in operational ground ATC systems;
- Derive deeper analysis of the associated operational benefits;
- Demonstrate the feasibility of an efficient centralized capture and distribution of ADS-C data to multiple ground consumers, in support of the Service Oriented Architecture vision in the ATM MP.

The items to be addressed in the frame of this VLD project continuity are:

1. Continue the ADS-C data collection campaign;
2. Improve offline analysis of data to quantify the operational benefits;
3. Demonstrate VDL and SATCOM complementarity in providing ATN connectivity;
4. Demonstrate an extension of the use of datalink beyond current VDL2 coverage thanks to SATCOM;
5. Demonstrate the feasibility of ADS-C collection and distribution service;
6. Demonstrate the use, in real-time, of data provided via a common service architecture;
7. Demonstrate the easy access to ADS-C data to consumers (e.g. Network Manager);
8. Demonstrate in a live environment the use of new applications from Wave 1 IR and, potentially, also applications developed in Wave 2.

This is a more detailed list of activities that should be covered:

1. Continue the ADS-C data collection campaign:

The aim of this aspect is to gather and record a larger dataset of ADS-C data than what has been achieved by DIGITS. This is required to enable the quantification of benefits of the various applications, and to support the development of safety cases for the deployment of ADS-C data in end-systems.

The data will be made available for use by IR wave 2 solutions working in the area, such as e.g. solutions PJ.18-W2-53 & PJ.18-W2-56. For this aspect, only already equipped airframes will be considered, in order to avoid the delay that the installation of new avionics would have.

2. Improve offline analysis of data to quantify the operational benefits:

Analytical methods would be employed to assess the benefits of using ADS-C data to support ATM processes. This shall include quantification of certain metrics (for example stability and trends of predictions), and assessment of operational influences on ADS-C data. This aspect would provide rigorous analytical evidence to complement pre-operational and shadow-mode demonstrations and validation under IR wave 2.

3. Demonstrate VDL and SATCOM complementarity in providing ATN connectivity:

The ground and airborne industries will develop (up to certification) systems capable of exchanging ADS-C data according to ATS Baseline 2 datalink delivered over SwiftBroadband-Safety (SB-S) SATCOM technology as proposed in the Demonstration Plan of wave 1 project PJ.14-02-02.

The PJ.14-02-02 SATCOM Demonstration Plan purpose is to reinforce the "Enabling Aviation infrastructure" key feature of SESAR 2020 by demonstrating the ATM benefits that can be realized through the use Air traffic services (ATS) datalink using SATCOM Class B solution (solution #109) for the downlink of 4D trajectory data in ground systems.

The demonstration would also validate the seamless transition from SATCOM to VDL mode 2 connection in long-haul flights equipped with both.

4. Demonstrate an extension of the use of datalink beyond current VDL2 coverage thanks to SATCOM:

The current DLS IR mandates data link only for the Upper Area (formally > FL285) and the VDL2 coverage for safety critical ATC-applications is mainly based on this need. With satellite communication a lower coverage will be feasible, which will be required to satisfy the coverage needs for PCP AF#6 (no differentiating exists between lower and upper area operations in AF#6). In a joint venture with the IRIS IOC project a complete European lower level coverage can be generated by analysing the ADS-C equipped revenue flights.

5. Demonstrate the feasibility of ADS-C common service:

A small number of project actors act as service providers. A given flight is assigned to a specific service provider, who establishes ADS-C contracts with the aircraft for its entire trajectory across the trial region (Europe). The downlinked data will then be published via a ground-ground service (e.g. using the SWIM or Flight Object). A standard contract set is defined that meets the common needs of all ground data consumers. The principle benefit is that ADS-C data required by multiple ground stakeholders will only be downlinked from the aircraft once, reducing demand on the data-link communications network bandwidth/capacity (and associated costs). This aspect addresses service architecture aspects of ADS-C data provision. The ground infrastructure required for the VLD would be an evolution of that developed in PJ.31 wave 1.

6. Demonstrate the use, in real-time, of data provided via a common service architecture:

The purpose is to demonstrate that a common service architecture is capable of providing data to the performance required to support selected end processes. This aspect could include the demonstration of one or more applications, for example the integration of EPP data to build the arrival sequence in a shadow-mode AMAN system, or to build the traffic picture in a shadow-mode flow management tool. For some applications, it should be sufficient to demonstrate that data can be received by the end user to a sufficient performance to meet the performance requirements of the end system, without establishing a shadow-mode system in the VLD. The demonstration shall look into the needed safety and security measures, which highly likely should target at a Software Assurance Level Requirements (SWAL3) compliant system for an operational deployment in the end. SWIM is the candidate, where it shall be noted that some experience was gained already during SESAR 1 under exercise 04.03-VP-030.

7. Demonstrate the easy access to ADS-C data to consumers (e.g. Network Manager):

Establishing ADS-C contracts directly with an aircraft should not be realistic for smaller/less demanding data users, such as an Airline Operations Centre (AOC), Airport Operations or flow management systems. This aspect aims to demonstrate the provision of elements of ADS-C data to an end-user via e.g. a graphical web portal (SWIM), subject to appropriate access controls. The benefit is a lower barrier for entry to participate in Trajectory Based Operations (TBO). This aspect could also be a useful means to raise the awareness of the benefits of ADS-C data, which could encourage early adoption and can reveal not-yet-studied less safety critical users and applications outside the currently demonstrated ATC use.

8. Demonstrate in a live environment the use of new applications from Wave 1 IR:

During Wave 1 several IR projects are looking into the use of ADS-C data to improve tools and applications. Some of these applications can be assessed as mature enough to evolve to be demonstrated in a shadow mode or (pre-) operational environment e.g. TP improvements as assessed under PJ.18-06a.

Please note that some of the aspects listed above require airline equipage and participation. These must be secured through the partners in the consortium conducting this project or subcontracted by them. There will be no Open VLD call to complement this call.

As expected in the applicable template, the demonstration report (DEMOR) shall clearly document any feedback / update related to the operational / technical requirements available in the datapacks from those solutions under the scope of the VLD. In case the demonstration project covers new solutions that have not been researched in SESAR yet, the DEMOR shall include the relevant operational and technical requirements that would be needed for the eventual industrialization and deployment of these new solutions. The project shall ensure that the information in the ATM master plan related to the scope of the VLD (e.g. SESAR Solution, OI steps, enablers) is keep up to date and reflect the results obtained by the project.

The demonstration contributes to this set of key principles in line with the ATM Master Plan 2020:

Principles		How does the solution contribute to these principles?
Added value for the ATM network	Defragmentation of service provision	The VLD contributes to demonstrate the feasibility of an efficient centralized capture and distribution of ADS-C data to multiple ground consumers, in support of the Service Oriented Architecture vision in the ATM MP.
	Interoperability	Complete the progressive integration of ADS-C data in operational ground ATC systems
	Sharing of infrastructure	Centralized infrastructure to capture and distribute ADS-C data
	Scalability	N/A
Increase network performance (capacity, environment) and/or better access to airports including regional/secondary airports		Reduction in controller intervention through more accurate conflict detection would lead to increase ATCO productivity and then increase airspace capacity.

Deployment oriented outcome	This VLD continues the work under the current DIGITS and DIGITS-AU projects beyond mid-2020 in order to accelerate the readiness for the deployment. The VLD objectives support the objectives of PCP regulation e.g. AF-6.

Relevant links to the ATM Master Plan Level 2 (DS19p):

This demonstration covers solutions that address the Key R&D needs identified in the ATM Master Plan 2015 "Performance-based trajectory prediction" and "Future satellite communications datalink". The demonstration also contributes to accelerate transition into deployment of AF-6 related functionalities (Essential operational change "Initial trajectory information sharing"). The VLD contributes to ATM Master Plan 2020 EOCs "Trajectory-based operations" and "CNS infrastructure and services".

The relevant SESAR solutions are #115 and #109 from SESAR 1 and PJ.18-06a from SESAR 2020 Wave 1.

List of acronyms

Acronym	Long Name / Definition
4D	4 Dimensions
AAS	Airspace Architecture Study
AAS TP	Airspace Architecture Study Transition Plan
ABAC	Accrual Based Accounting
ACAS	Airborne Collision Avoidance System
ACC	Area Control Center
A-CCD	Advanced Continuous Climb Departure
A-CDA	Advanced Continuous Descent Approach
A-CDM	Airport Collaborative Decision Making
ACS	Area Control Surveillance
ADB	ADministrative Board
ADDEP	Airport Departure Data Entry Panel
ADQ	Aeronautical Data Quality Requirements
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
ADEXP	ATS Data Exchange Presentation
ADSP	ATM Data Services Provider
AEEC	Airlines Electronic Engineering Committee
AeroMACS	Aeronautical Mobile Airport Communications System
AF	ATM Functionality
AFD	ATC Full Datalink
AFISO	Aerodrome Flight Information Service Officer
AFUA/ASM	Advanced Flexible Use Airspace/Airspace Management
A/G	Air/Ground
AGL	Airfield Ground Lighting
AHRS	Attitude and Heading Reference System
AI	Artificial Intelligence

AIGS	Adaptive Increased Glide Slope
AIM	Aeronautical Information Management
AIRM	ATM Information Reference Model
AIXM	Aeronautical Information Exchange Model
AM	Amplitude Modulation
AMAN	Arrival MANager
AMC	Acceptable Means of Compliance
AMDAR	Aircraft MET Data Relay
AMG	Eurocontrol Asterix Management Group
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
AOC	Airline Operation Communication
AOP	Airport Operation Plan
A-PNT	Alternative Position, Navigation and Timing
APOC	AirPort Operations Centre
APP	Approach Centre
APS	Approach Control Surveillance
AR	Augmented Reality
ARAIM	Advanced Receiver Autonomous Integrity Monitoring
ARES	Airspace Reservation/Restriction
ASAS	Airborne Separation Assistance System
A-SGMCS	Advanced Surface Movement Guidance and Control System
ASPA	Airborne Spacing
ASR	Automatic Speech Recognition
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management

ATM MP	ATM Master Plan
ATM RPP	Air Traffic Management Requirements and Performance Panel
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSA ITP	Air Traffic Situation Awareness- In-Trail Procedure
ATSAW	Airborne Traffic Situation Awareness
ATSEP	Air Traffic Safety Electronics Personnel
ATSU	Air Traffic Services Unit
AU	Airspace Users (Civil)
AUP	Airspace Use Plan
AUTOMETAR	Automated Meteorological Terminal Air Report
B2B	Business-to-Business
BA	Business Aviation
BADA	Base of Aircraft DAta
CA	Collision Avoidance
CANSO	Civil Air Navigation Services Organisation
CAS	Calibrated airspeed
CASA	Computer Assisted Slot Allocation
CATC	Conflicting ATC Clearances
CAVS	CDTI (Cockpit Display Of Traffic Information) Assisted Visual Separation
CBA	Cost Benefit Analysis
CCD	Continuous Climb Departure
CCO	Continuous Climb Operations
CCOM	Coordination Committee
CCS	Capacity Constrained Situation
CDA	Continuous Descent Approach
CDM	Collaborative Decision Making
CD&R	Conflict Detection and Resolution
CDG	Charles de Gaulle airport

CDO	Continuous Descent Operations
CDTI	Cockpit Display Of Traffic Information
CFSP	Computer Flight Plan Software Provider
CMAN	Centre Manager
CMAC	Conformance Monitoring Alerts for Controllers
CMAC	Civil-Military ATM Coordination
CNS	Communication, Navigation, Surveillance
CNSS	Communication, Navigation, Surveillance and Spectrum
COCR	Communications Operating Concept and Requirements
COM	Communication
COTS	Commercial off-the-shelf
CP	Common Project
CP n.m	Coordination Plan FAA/SESAR
CPDLC	Controller–Pilot Data Link Communications
CSA	Critical Sensitive Area
CSPO	Closely Spaced Parallel Operations
CSPR	Closely Spaced Parallel Runways
CTA	Controlled Time of Arrival
CTOT	Calculated Take Off Time
CVS	Combined Vision System
CWP	Controller Working Position
DAA	Detect and Avoid
DAB	Digital Audio Broadcast
DAC	Dynamic Airspace Configuration
DAP	Downlinked Aircraft Parameter
DART	Data-driven Aircraft Trajectory
DCB	Demand and Capacity Balancing
dDCB	Dynamic Demand and Capacity Balancing

DEMOP	Demonstration Plan
DEMOR	Demonstration Report
DFMC	Dual Frequency Multi-constellation
DCPC	Direct Controller Pilot Communication
DEVG	Derived Equivalent Vertical Gust
DL	Data Link
DLS	Data Link Services
DMA	Dynamic Mobile Area
DMAN	Departure Manager
DME	Distance Measurement Equipment
DPI	Departure Planning Information
DS	Data Set
DSB AM	Double-Side Band Amplitude Modulation
DT	Dual Thresholds
E-AMAN	Extended-AMAN
E-TMA	Extended-TMA
EASA	European Aviation Safety Agency
EASCG	European ATM Standards Coordination Group
EATMA	European ATM Architecture
EBS	Enhanced Braking System
EC	Executive Controller
ECAC	European Civil Aviation Conference
EDA	European Defence Agency
EDR	Eddy Dissipation Rate
EFB	Electronic Flight Bag
eFPL	Extended Flight Plan (FF-ICE / FIXM based FPL)
EFVS	Enhanced Flight Vision System
EHS	Enhanced Surveillance
EGNOS	European Geostationary Navigation Overlay Service

EOBT	Estimated Off Block Time
EOC	Essential Operational Change
EOCVM	European Operational Concept Validation Methodology
EPAS	European Plan for Aviation Safety
EPP	Extended Projected Profile
ER	Exploratory Research
ER/APP	En-route/Approach
ESV	Expanded Service Volume
ETA	Estimated Time of Arrival
EU	European Union
EUR	ICAO European Region
EUROCAE	European Organisation for Civil Aviation Equipment
EVS	Enhanced Vision System
FAA	Federal Aviation Administration
FAP	Final Approach Fix
FCFS	First Come First Serve
FCI	Future Communication Infrastructure
FCU	Flight Control Unit
FDPS	Flight Data Processing System
FF-ICE	Flight and Flow Information for the Collaborative Environment concept
FIM	Flight deck Interval Management
FIS	Flight Information Service
FIS-B	Flight Information Service - Broadcast
FL	Flight Level
FM	Frequency Modulation
FMP	Flow Management Position
FMS	Flight Management System
FO	Flight Object
FOC	Final Operational Capability

FOC	Flight Operations Centre
Flightpath 2050	Report of the High Level Group (HLG) on Aviation and Aeronautics Research established by the European Commission in December 2010, setting out a new vision for the aviation sector by 2050
FPD	Fixed Profile Descent
FPL	Flight Plan
FRA	Free Routing Airspace
FRAP	Further Runway Aiming Point
FSFS	First Scheduled First Served
GA	General Aviation
GA/R	General Aviation & Rotorcraft
GANP	Global Air Navigation Plan (from ICAO)
GAST	GBAS Approach Service Type (of different types GAST-C, GAST-D, GAST-F)
GAT	General Air Traffic
GBAS	Ground Based Augmentation System
G/G	Ground/Ground
GLS	GBAS Landing System
GML	Geography Mark-up Language
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	European GNSS Agency
H2020	Horizon 2020 Framework Programme
HALE	High Altitude Long Endurance
HF	High Frequency
HMD	Helmet Mounted Display
HMI	Human Machine Interface
HP	Human Performance
HUD	Head-Up Display
JTIDS	Joint Tactical Information Distribution System
I4D	Initial 4 Dimensions

IA	Innovation Action
iAMAN	Initial AMAN (pre-departure target time allocation based on local AMAN logic)
IATA	International Air Transport Association
IBA	Identified Beneficiary Action
ICAO	International Civil Aviation Organisation
ICAO CP	ICAO Communication Panel
ICNS	Integrated CNS
ICT	Information and Communication Technologies
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
IGS	Increased Glide Slope
ILS	Instrumental Landing System
IM	Interval Management
IMU	Inertial Measurement Unit
INAP	Integrated Network Management and extended ATC Planning Function
INCS	Independent Non-Cooperative Surveillance
INS	Inertial Navigation Systems
INTEROP	Interoperability Requirements
IOC	Initial Operational Capability
IOP	Interoperability
IoT	Internet of Things
IPS	Internet Protocol Suite
IR	Implementing Rule
IR	Industrial Research & Validation
IRS	Inertial Reference System
IRS	Interface Requirements Specification
KPA	Key Performance Area
KPI	Key Performance Indicator

LCS	Low Cost Surveillance
L-DACS	L-band digital aeronautical communications system
LIDAR	Light Detection And Ranging
LNAV	Lateral Navigation
LEO	Low Earth Orbit
LOA	Letter of Agreement
LPV	Localiser Performance with Vertical guidance
LTE	Long Term Evolution
LTM	Local Traffic Management
LVC	Low Visibility Conditions
LVP	Low Visibility Procedure
MAC	Mid-Air Collision
MASPS	Minimum Aviation System Performance Standards
MAWP	SESAR 2020 Programme Multi-Annual Work Programme, as adopted by the SJU Administrative Board through decision ADB(D)-05-2015
MC/MF	Multi Constellation / Multi Frequency
MCP	Mode Control Panel
Members	2 Founding Members (the European Union and EUROCONTROL) and 19 stakeholder Members of which all apart from the EU are signatory to a Membership Agreement or Accession Agreement
MET	Meteorological / Meteorology
METAR	Meteorological Aerodrome Report
MGA	SESAR JU Model Grant Agreement for Members
MGAM	SESAR JU Model Grant Agreement
MIDS	Multifunctional Information Distribution System
MLAT	Multilateration
MOPS	Minimum Operational Performance Specifications
MP	Master Plan
MRAP	Multiple Runway Aiming Points
MRS	Minimum Radar Separation

MSP	Multi Sector Planning
MSPSR	Multi-Static Primary Surveillance Radar
MTCD	Medium-Term Conflict Detection
MULTILAT	MULTILATeral Surveillance
MWS	Minimum Wake Separation
NACC	North American, Central American and Caribbean ICAO region
NASA	National Aeronautics and Space Administration
NAV	Navigation
NEASCOG	NATO/EUROCONTROL ATM Security Coordinating Group
NFR	Non-Functional Requirements
NM	Nautical Miles
NM	Network Manager
NMf	Network Management Function, organised as integrated regional / sub-regional / local layers and supporting Collaborative Network Management
NMOC	Network Manager Operations Centre
NOP	Network Operation Plan
NOTAM	Notice to Airmen
NOZ	Normal Operating Zone
NRA	Non Radar Airspace
NSA	National Supervisory Authority
NSP	Navigation Systems Panel
NTZ	No Transgression Zone
OAT	Operational Air Traffic
OBACS	On-board Braking Action Computation System
OCC	Operations Control
OFZ	Obstacle Free Zone
OI	Operational Improvement
OJTI	On-the-Job Training Instructor
OLDI	On-Line Data Interchange

OOA	Out Of the European Regulation Area
OPS	Operations
ORD	Optimised Runway Delivery
OSI	Open Systems Interconnection
OSED	Operational Services and Environment Description
PANS-ATC	Procedures for Air Navigation Services – Air Traffic Control
PANS-ATM	Procedures for Air Navigation Services – Air Traffic Management
PANS-OPS	Procedures for Air Navigation Services – Aircraft OPerationS
PBAOM	Performance Based Aerodrome Operational Minima
PBN	Performance Based Navigation
PBS	Performance Based Surveillance
PC	Planning Controller
PCP	Pilot Common Project
PENS	Pan-European Network Services
PFD	Predicted Flight Data
PI	Performance Indicator
PinS	Point in Space
PIREP	Pilot REPort
PPP	Public Private Partnership
P-RNAV	Precision Area Navigation
PSR	Primary Surveillance Radar
PTR	Profile Tuning Restriction
PWS	Pair Wise Separation
QoS	Quality of Service
R&D	Research and Development
R&I	Research & Innovation
R/T	Radio Telephony
RA	Resolution Advisory (ACAS)
RAD	RADar

RAIM	Receiver Autonomous Integrity Monitoring
RC	Rotorcraft
RBT	Reference Business Trajectory
RECAT-EU	European Wake Vortex Re-CATegorisation
RF	Radius to Fix
RFI	Radio Frequency Interference
RIA	Research and Innovation Action
RLP	Required Link Performance
RMT	Reference Mission Trajectory
RNAV	Area NAVigation
RNP	Required Navigation Performance
RNP-AR	Required Navigation Performance Authorization Required
ROAAS	Runway Overrun Awareness and Alerting System
ROC	Rate Of Climb
ROD	Rate Of Descent
ROT	Runway Occupancy Time
RPAS	Remotely Piloted Aircraft System
RSP	Required Surveillance Performance
RTA	Required Time of Arrival
RTC	Remote Tower Centre
RTCA	Radio Technical Commission for Aeronautics
RTM	Remote Tower Module
RTS	Real Time Simulation
RWC	Remain Well Clear
RWY	Runway
RWYCC	Runway Condition Code
S&M	Sequencing & Merging
SARPS	Standards and Recommended Practices
SATCOM	SATellite COMmunications

SBAS	Satellite-Based Augmentation System
SBB	Swift Broad Band
SBT/RBT	Shared Business Trajectory/Reference Business Trajectory
SDD	Service Description Document
SDN	Software-defined networking
SDM	SESAR Deployment Manager
SE	System Engineering
SES	Single European Sky
SESAR	Single European Sky ATM Research
SESAR 2020	The SESAR 2020 research and innovation programme, also referred to as the SESAR 2020 Programme or SESAR 2020 R&I programme
SES PS	Single European Sky Performance Scheme
SID	Standard Instrument Departure Route
SFL	Selected Flight Level
SJU	SESAR Joint Undertaking
SMART	Specific, Measurable, Agreed, Relevant, Timely
SME	Small and Medium-sized Enterprise
SMT/RMT	Shared Mission Trajectory/Reference Mission Trajectory
SNE	Seconded National Expert
SNI	Simultaneous Non-Interfering
SoA	Service oriented Architecture
SOIR	Simultaneous Operations On Parallel Or Near-Parallel Instrument Runways
SP	Service Provider
SPD	Single Programming Document
SPI	Surveillance Performance and Interoperability
SPO	Single Person Operations
SPR	Safety and Performance Requirements
SRAP	Second Runway Aiming Point
SSR	Secondary Surveillance Radar

STAM	Short Term ATFCM Measures
STAR	Standard Terminal Arrival Route
STCA	Short Term Conflict Alert
SWAL	Software Assurance Level Requirements
SUR	Surveillance
SV	Synthetic Vision
SVGS	Synthetic Vision Guidance System
SVS	Synthetic Vision System
SWIM	System Wide Information Management
SWIM BP	SWIM Blue Profile
SWIM GP	SWIM Green Profile
SWIM YP	SWIM Yellow Profile
SWIM-TI	System Wide Information Management Technical Infrastructure
TA	Traffic Alert (ACAS)
TACAN	TACtical Air Navigation
TAM	Total Airport Management
TBO	Trajectory Based Operations
TBS	Time Based Separation
TCAS	Traffic alert and Collision Avoidance System
TMA	Terminal Manoeuvring Area
TOBT	Target Off-Block Time
ToD	Top of Descent
TP	Trajectory Predictor
TPCS	Trajectory PrediCtion Service
TRL	Technology Readiness Level
TS	Technical Specifications
TT	Target Time
TTA	Target Time Arrival
TTG	Time To Gain

TTL	Time to Lose
TTOT	Target Take Off Time
TVALP	Technical Validation Plan
TVALR	Technical Validation Report
TWR	Tower
UAS	Unmanned Aerial System
UDPP	User Driven Prioritisation Process
UFB	Unmanned Free Balloon
UPMS	User Profile Management Systems
USSP	U-space Service Provider
UTM	UAS Traffic Management
UUP	Updated Airspace Use Plan
VALP	Validation Plan
VALR	Validation Report
VC	Virtual Centre
VDL	VHF Datalink (VDL)
VHF	Very High Frequency
VLD	Very Large-Scale Demonstration
VLL	Very Low-Level
VNAV	Vertical NAVigation
VOIP	Voice Over IP
VPA	Variable Profile Area
VSB	Virtual Stop Bar
VTS	Vehicle Tracking System
WA	Working Area
WAM	Wide Area Multilateration
WDS	Weather Dependent Separation
WG	Working Group
WOC	Wing Operations Centre

WVE	Wake Vortex Encounter
XML	eXtensible Markup Language