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PJ07 OAUO

INITIAL 4D MISSION TRAJECTORY DEVELOPMENT WITH INTEGRATED DMA TYPES 1 AND 2 SUPPORTED BY AUTOMATION AND DYNAMIC CIVIL-MILITARY CDM

This PJ07-W2-40 Contextual Note is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874465 under European Union's Horizon 2020 research and innovation programme.

Abstract

This V3 Contextual note provides the SESAR Solution PJ07-W2-40 description for industrialisation consideration.

The new operating methods validated by the solution bring evolutions to an integrated approach for the key ATM concepts supporting enhanced civil-military cooperation and interoperability, namely Mission Trajectory and Advanced Flexible Use of Airspace.

The new airspace design principles for airspace reservations/restriction validated as part of mission trajectory development phase and their technical support deliver flexibility and dynamicity to the airspace configuration processes with expected performance benefits in the areas of en-route airspace capacity (with no detrimental impact on safety), a reduction in fuel burn and CO2 emissions and improvements in time efficiency. Key performance result is the safeguard of military mission effectiveness.

Improvements to processes and technical tools are identified and should be considered in the industrialization phase to maximize the efficiency of the validated solution.

A key recommendation for expanding the concept developed in PJ.07-W2-40 is to involve the sub-regional/local Air Traffic Flow and Capacity Management (ATFCM) and sub-regional/national Airspace Management (ASM) actors in the associated dynamic civil-military CDM.

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1 Purpose

This contextual note complements the technical data pack comprising the PJ07-W2-40 solution deliverables required for further industrialization/deployment.

The document captures and presents the key outcomes of the R&D activities performed by the Solution team aiming at guiding the reader towards the details presented in the deliverables.

It provides to any interested reader (external and internal to the SESAR programme) an introduction to the Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as recommendations to be considered during the industrialization phase or as part of deployment.

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2 Improvements in Air Traffic Management (ATM)

2.1 SESAR Solution PJ07-W2-40: a summary

The Solution contributes to the Essential Operational Change (EOC) 'Fully Dynamic and Optimised Airspace' aiming at increasing the flexibility in civil-military coordination by connecting the mission trajectory management with the allocation of airspace reservation (in the context of this solution, dynamic mobile areas type 1 and type 2) throughout sub-regional/local collaborative planning processes.

It combines, develops, and further validates the effort of two previous SESAR 2020 wave 1 solutions (PJ07.03 and PJ08.01) by bringing together well-developed elements of the entire Mission Trajectory (MT), Advanced Flexible Use of Airspace (AFUA), and advanced ASM (AASM) concepts into the description and validation of new operating methods.

The new operating methods enable more flexibility and dynamicity to the planning of airspace structures configuration and the development of mission trajectory to be considered by all users performing activities in temporary restricted/reserved airspace and by the concept of dynamic airspace configuration DAC (Dynamic Airspace Configurations). The solution provides a detailed description of the integrated military Air Traffic Management (ATM) demand that evolves through trajectory lifecycle undertaking modification through local level CDM (Collaborative Decision-Making).

A dynamic coordination between Wing Operation Centre (WOC) and local DAC actors, specifically national Airspace Management (ASM) and local Air Traffic Flow & Capacity Management (ATFCM), throughout CDM on a single 4D Mission Trajectory data set supported by automation of impact assessments is a key element for this solution.

The key operational and technical improvements brought by the solution reside in the negotiation and allocation of DMA type 1 and 2, throughout a civil-military CDM, as integral part of MT development in collaborative sub-regional/national planning processes, by using 4 D trajectory data, and automation support for impact assessments.

The main outcomes consist of new operating methods that enable full preservation of military operational requirements, and a significant reduction of airspace reservation effect on civil traffic, with consequent contribution to ATM performance expectations, especially in the areas of capacity, fuel efficiency and CO2 emissions.

The solution is applicable to Very High, High, and Medium Complexity sub-operating environments of En-Route operating environment. The validation has been performed in full Free Route Airspace operations, with civil traffic sample improved with 2035 forecast and military scenario suited to the same timeline.

Important to note, neither the MT nor the DMA concepts do not challenge national prerogatives on military operations and training, which are in the scope of national defence and security decisions.

With the validated operating methods proposed by the solution, the Military will have an additional option to effectively operating within the future operational and technical ATM environment.

2.2 Evolutions

The main value added by the validated solution consists of new operating methods for a collaborative civil-military planning process at local level, which is based on the integration of military ATM demand, ASM and ATFM data enabling a dynamic optimization of airspace segregation in line with the evolution of traffic demand.

The new operating methods validated by the solution bring the following operational and technical evolutions to the key concepts driving civil-military cooperation and interoperability in the future European ATM system:

- An Early Flight Intent step in the MT development process, which allows the sub-regional/national ASM function to identify in collaboration with the local ATFCM function and propose to WOC an ASM solution for the adaptation of DMAs, based on pre-defined flexible parameters.
- A negotiation process between WOC and sub-regional/national ASM for the optimization of DMAs as integral part of MT development, providing the military airspace user the possibility to assess the impact of DMA changes to the MT profile.
- The shift of some of the tasks currently performed at ASM strategic level to ASM pre-tactical level concerning the design and allocation of airspace reservations and civil-military CDM procedures.
- Closer coordination between sub-regional/national ASM and local ATFM as integral part of a DAC function in the decision-making process for the allocation of airspace reservations
- The consolidation of ‘ATC volumes’ feature and procedure as a valid input provided to WOC concerning the local ASM and ATFM constraints to traffic flow accommodation.
- A WOC-ASM tool, which supports the WOC operators to successfully define and modify the mission planning and airspace needs together with the attributes of the DMA type 1 and 2.
- A sub-regional/national ASM tool prototype (Common Airspace management Tool - CAT), which enables the integration of ATFM information allowing DAC operator to create, manage, visualize, and share ATC volumes with the WOC. The capability of the tool to optimize and allocate DMA type 1 and 2 to reduce impact on civil traffic and support better usage of airspace capacity has been confirmed.
- In support of civil-military CDM, a ‘what-if’ capability provided by the CAT tool facilitates assessment and comparison of different 3D allocation solutions for the DMA type 1 and type 2 to minimize the impact of airspace segregation on planned trajectories within ANSP area of responsibility.
- Tool and services support to a dynamic sharing and updating of MT with DMA type 1 and type 2 data set amongst concerned actors. With the WOC-MT tool the operator (Mission Planner) can submit an OAT FPL including the mission trajectory with integrated DMA types 1 and 2.

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3 Operational Improvement Steps (OIs) & Enablers

OI steps and ENs validated by the solution:

SESAR Solution ID	SESAR Solution Title	OI Steps ID	OI Steps Title	Enabler ID	Enabler Title	OI Step/Enabler Coverage
PJ-07-W2-40	Initial 4D Mission Trajectory development with DMA type 1and 2 supported by automation and dynamic civil-military CDM	AOM-0304-B	Integrated management of Mission Trajectory in trajectory-based operations environment	AAMS-16a	Airspace management functions equipped with tools able to deal with free-routing	**OI step:** Fully • **Enablers**: • Use
				AAMS-16b	Airspace management system equipped with tools able to deal with flexible use of airspace	• Use
				MIL-0108	Exchange of specific MT data (ARES description) in standard format	• Develop
PJ-07-W2-40	Initial 4D Mission Trajectory development with DMA type 1 and 2 supported by automation	AOM-0208-B	Dynamic Mobile Areas (DMA) of types 1 and 2	AAMS-16a	Airspace management functions equipped	**OI step:** Fully **Enablers:** • Use

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SESAR Solution ID	SESAR Solution Title	OI Steps ID	OI Steps Title	Enabler ID	Enabler Title	OI Step/Enabler Coverage
	and dynamic civil-military CDM				with tools able to deal with free-routing	
				MIL-0108a	Integration of DMA type 1 and 2 into the development of MT	• Develop
PJ-07-W2-40	Initial 4D Mission Trajectory development with DMA type 1 and 2 supported by automation and dynamic civil-military CDM	AUO-0216	Shared Mission Trajectory Data	MIL-0108b	WOC mission support system enhanced to enable converting DMA type 1 and 2 data into the standard format	**OI step:** Fully **Enablers:** • Develop
PJ-07-W2-40	Initial 4D Mission Trajectory development with DMA type 1and 2 supported by automation and dynamic civil-military CDM	**AUO-0210**	Participation in CDM through iSMT and Target Time (TTO) negotiation	AOC-ATM-14	Upgrade of WOC system to handle improved OAT flight plans	**OI step:** Fully **Enablers:** • Use
				AOC-ATM-20	Sharing of trajectory data between AOC / WOC and the ATM world using B2B web	• Use
				MIL-		• Develop

SESAR Solution ID	SESAR Solution Title	OI Steps ID	OI Steps Title	Enabler ID	Enabler Title	OI Step/Enabler Coverage
				0105	services	
				MIL-0106	CDM data integrated into the Wing Operations Centre Mission Support System	• Develop
				PRO-076	Wing Operations Centre Mission Support System enhanced to support the CDM process Procedures for the iSMT in the CDM process	• Develop

Table 1: OI steps and Enablers

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4 Background and validation process

PJ07-W2-40 validation has built upon outstanding results from SESAR 2020 wave 1 concerning mission trajectory management (SESAR Solution PJ07.03) and DMA type 1 and 2 integration into DAC (SESAR Solution PJ08.01).

The figure below provides a high-level description of solution 40 scope in relation to previous relevant validation activities. It has to be highlighted that the scope is strictly framed by national-local civil-military collaborative planning processes with no interactions at network level. The scope is very relevant considering the national-local scope of MT development as well as the sole national responsibility in ASM processes concerning airspace reservations/restrictions.

Relevant validation results (V3 ongoing maturity level) achieved in PJ07.03:

- Technical and operational feasibility of Mission Trajectories planning, using the improved Operational Air Traffic Flight Plan (iOAT FPL), compliant with the complete set of ATM Network rules and restrictions, without compromising military mission needs.
- The integrated management of mission trajectories and VPA (Variable Profile Area) design type of ARES (Airspace Reservation/Restriction), in the ATM planning phase, throughout information exchange via iOAT FPL between WOC, NM, and ATC actors.
- Operational and technical feasibility of using an exemption policy mechanism for mission trajectories which could not comply with network restrictions without compromising mission needs.
- A CDM process amongst WOC, NM, and ATC actors for the revision of mission trajectories shared via the iOAT FPL to adjust military ATM demand to network management requirements.
- SWIM compliant B2B services for flight plan filing and message exchange between WOC, NM, and ATC systems.

PJ 08.01 validation results (V2 maturity level) concerning the DMA type 1 and type 2:

- The DAC concept successfully integrates ASM and ATFCM in a single logical and continuous process. Considering and assessment of DMAs and traffic flows and performing CDM in the planning phase bring benefits for civil and military users as well as to the ATM network.
- The use of DMAs minimizes the impact of airspace segregation on the traffic demand while fulfilling DMA user request. A key element enabling such a minimisation is represented by the flexible parameters attached to DMA definition, which could refer to: target time over ARES entry (TOT ARES), minimum/maximum flight level, distance (transit time) from/to a specific reference point, distance (transit time) between successive DMA activations, geographical positioning of successive DMAs, time of activation/deactivation. The flexible parameters are considered in the automatic optimization of DMAs allocation.
- Definition of DMA in accordance with MT concept requirements is possible. The DMA parameters defined and allocated by the tool are compatible with the requirements of mission trajectory concept. The application of DMA design principles enables a flexible access to airspace to military AU.

Solution 40 validation activities have fulfilled the following priorities and ambitions:

- The definition, sharing and management at sub-regional/local level of an integrated military ATM demand comprising the trajectory profile and DMA type 1 and type 2 is operationally and technically feasible and provides performance benefits to airspace users (civil and military) and ATM system in the planning phase.
- A civil-military CDM process at sub-regional/local level for the adaptation of MT to ATFM requirements throughout negotiation of planning target times (TTO) is feasible and brings performance benefits to ANSPs (ASM and ATFM integrated into a DAC function) and civil airspace users.

The SESAR Solution has been validated through two sessions of fast time simulations and one gaming exercise with real time simulation and human-in-the-loop. The gaming technique applied during the validation enabled the exploration of real-life situations where the actors interacted dynamically with a choice of action in order to meet their objectives. It allowed to validate the iMT (initial Mission Trajectory) with DMA (Dynamic Mobile Areas) type 1 and 2 management processes (and the associated CDM processes) framed by local planning phase, to assess the technical feasibility of the supporting tools as well as the efficiency of tool support to information exchange.

A summary of the validation exercise specifications is presented hereafter:

Title	**Civil-Military performance benefits of the management of Mission Trajectories with integrated DMA type 1 and type 2 in ATM planning phase**
Description	The exercise validates the processes and tool prototypes for: • Integrated definition and development of iMT with DMA type 1 and type 2 in sub-regional/local ATM planning phase • Participation of iSMT with DMA type 1 and type 2 to sub-regional/local level CDM for balancing capacity with demand with planning target times (TTO/iMT)
V phase	**V3**
Actors	
Military Airspace User - WOC	The MT concept explicitly describes WOC as a function that can be distributed amongst different entities with different roles and actors according to national military organisations and infrastructures. In the context of the solution, roles actors and responsibilities affiliated with a WOC function are used to explain operational activities and information exchanges between all relevant nodes along all the phases of iMT lifecycle.
Sub-regional/national ASM	The main role is to allocate DMA type 1 and 2 based on collected WOC requests and on integrated ASM-ATFM requirements and to build/update a complete local airspace configuration picture. The ultimate goal is to satisfy WOC request and to accommodate traffic demand.
Sub-regional/local ATFM	The main task is to provide the most effective ATFM service to ATC and AOs. Within the scope of the Solution, there are two main roles assigned to the sub-regional/local ATFM operational node: • Provide ATFM information to sub-regional/national ASM for the optimization of DMA allocation • Identify and negotiate with WOC planning target times (TTO/iMT) to alleviate airspace capacity/complexity issues.
Platforms	

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Platform	Purpose
WOC ASM - (Wing Operation Centre – Airspace Management)	ARES management and negotiation, supporting the selection/definition of appropriate ARES that comply with the operational objectives; measure the impact of ATM on mission operational requirements
WOC - (Wing Operation Centre –DMAS)	DMAS - Display of Multi-Source Air Situation (DMAS), interoperability with SESAR Environment
CAT (Common Airspace Tool)	ARES/DMA allocation and CDM process between WOC and local DAC (ASM-AMC and ATFM-LTM) regarding DMA allocation; collection via B2B and de-confliction of users' requests for ARES/DMAs; based on historical GAT flows and planned ATC sectorisation, location for DMA, to minimise its impact on civil traffic and capacity; measure performance improvements
R-NEST (Research Network Strategic Tool)	Provide traffic scenarios simulation; calculate mission trajectories; support design of DMAs and ATC sectors; measure performance improvements.
Operating Environment (OE)	**Sub OEs**
En-route	En-route Very High Complexity En-route High Complexity En-route Medium Complexity

Organization	
Start Date Preparation Activity	01 OCT 2021
Fast time Simulations session 1	21 to 23 FEB 2022
Fast time Simulations session 2	07 to 11 MAR 2022
End Date Preparation Activity	14 MAR 2022
Start Date Exercise Dry Run	15 MAR 2022
End Date Exercise Dry Run	17 MAR 2022
Start Date Exercise	05 APR 2022
End Date Exercise	07 APR 2022
Start Date Analysis and Reporting	11 APR 2022
End Date Analysis and Reporting	31 AUG 2022
Validation Coordinator	AIRBUS SAS
Validation Location	EUROCONTROL INNOHUB Brétigny, France
Status	<Completed>

Table 2: Validation exercise layout

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5 Results and performance achievements

Overall, considering that, airspace management will remain a sole national responsibility, the scope of concept development and validation activities performed by the solution as well as the results obtained are relevant to the maturity level pursued. The solution has achieved its validation objectives and fulfilled their associated success criteria with few limitations detailed in the validation report.

Based on the obtained results, it can be concluded that the integration of DMA type 1 and 2 into the definition and development of iMT provides more options to military for tailoring the changing mission requirements to the ATM planning phases and that the allocation of DMA type 1 and 2 within DAC processes supports airspace and traffic flow managers to dynamically adapt the configuration of airspace structures to the evolution of traffic demand. In addition, the concept supporting tools/functionalities, although requiring some improvements, can work coherently together and can deliver the required benefits.

The operational concept elements and the new operating methods are considered by the experts involved as practical for the integration of military mission requirements in the future ATM environment as defined by SESAR target concepts. The flexibility of DMA of types 1 and 2 provides clear benefits to airspace capacity through a significant reduction of airspace reservations impact on traffic demand, while ensuring preservation of military mission requirements.

5.1 OI steps maturity assessments

5.1.1 AUO-0216 — Shared Mission Trajectory

The solution fulfils expectations of the OI step and provides evidence of new operating methods with system support functionalities during the validation exercise. MT data generated during medium –to-short-term planning phase and matured in iterative exchange and CDM process with pertinent ATM actors were used within the thresholds acceptable by military AU in order to balance civil and military ATM demand and optimise airspace configuration.

5.1.2 AUO-0210 — Participation in CDM through iSMT and Target Time (TTO) negotiation

The validation conducted has provided evidence of the applicability of the planning ATM constraint TTO through trajectory cherry picking technique. It has been demonstrated that MT with DMA type 1 and 2 may be subject to planning ATM constraints, thanks to DMA flexible parameters. TTO feature allows DAC actors to optimize the accommodation of traffic demand within a predefined sector configuration by adjusting the ‘picked’ MT trajectory profiles so that to solve overload issues generated by airspace segregation.

5.1.3 AOM-0304-B — Integrated management of Mission Trajectory in trajectory-based operations environment

MT concept matured in the solution together with validation scenario have demonstrated the applicability of the ad hoc solutions in medium- and short-term planning phases. MT data was

shared and exploited by all pertinent DAC and WOC actors in order to optimise airspace configuration while maintaining mission objectives. Management of DMA allocation and integration into ATM operational environment through civil-military CDM demonstrates compatibility of MT concept with ATM network performance expectations.

5.1.4 AOM-0208-B — Dynamic Mobile Areas (DMA) of types 1 and 2

This operational improvement step has been validated through new operating methods and detailed description of the development and management of DMA type 1 and 2. Validation exercise has proved that conceptual aspects have been very well integrated into local ATM processes through human actions with system support. Given the flexibility of the DMA parameters it was possible to demonstrate benefits, which all participating actors could gain through seamless negotiation and collaboration in CDM processes.

5.2 Operational feasibility

All actors engaged in validation consider that new operating methods are feasible to their specific operational requirements.

Overall, the coordination between WOC and the ASM function of DAC based on dynamic exchange of information enables the definition and allocation of DMA type 1 and type 2 with full respect to military training requirements, while supporting minimization of airspace segregation impact on the accommodation of planned traffic demand. The DMAs have been defined and optimized as integral part of mission trajectory profile development, from definition to sharing via the iOAT FPL.

Specifically, the military mission planners had the opportunity to accept or reject the proposals for DMA changes and assess the impact of adaptations on mission trajectories, while the airspace manager weas able to fully utilize the flexibility provided by DMAs for optimizing the accommodation of traffic demand in close coordination with the local traffic flow manager.

The possibility to assess the impact of changes and adjust initial requests and/or improve alterations to impacted traffic demand with respect to other actor constraints based on improved exchange of information has proven the feasibility of civil-military CDM in the local ATM planning phase.

The identification, negotiation and allocation of a planning time constraint, the TTO, to mission trajectory has been proven as feasible. Once agreed, the TTO supports the alleviation of regional/local traffic complexity/capacity issues. The military experts expect that for more complex training missions that involve multiple types of ARES design (static, VPA and DMA) it will be more difficult to find an adequate TTO for the efficiency of the MT (feasibility of TTO diminishes). Therefore, it can be concluded that the TTO is very useful for DAC but applicability to military operational requirements needs to be assessed case by case.

Although not subject to validation, the concept development and validation exercise included aspects related to military mission priorities integration into the sharing, definition, and negotiation of MT integration into the overall traffic demand and airspace configuration picture. The conclusion is that priorities could be useful to alleviate complexity of civil-military CDM process.

The validation exercise has been performed in nominal conditions without addressing degradations generated by technical, operational, or environmental issues. Nominal conditions suit to a V3 gaming exercise with human in the loop, which focused on the integration of processes and technical tool

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prototypes based on a predefined scenario. The overall SESAR guidelines documentation for validation preparation and conduct does not specifically require use cases for degraded situation at this step of validation. Furthermore, the forecast tools for traffic simulations as well as the available simulation tools (DAC, R-NEST) have no capabilities to integrate degraded situation scenarios for V3 type simulations. Hence, nominal conditions are sufficient for a satisfactory level of confidence in the V3 validation results.

5.3 Technical feasibility

The operators using the ASM-CAT tool and WOC-MT tool prototypes rated the tools as acceptable and adequately supporting the execution of the tasks. The WOC-ASM tool supports the WOC operators to successfully define and modify the mission planning and airspace needs together with the attributes of the DMA type 1 and 2. However, the participants in the validation exercise identified potential technical improvements (such as the possibility to rotate in real time the DMA on the HMI or to address only specific change requests to DMA and not the entire data set), which could improve the performance of the tasks and contribute positively to the expected benefits of the concept.

The WOC capability to share with DAC integrated trajectory and DMA data set has been demonstrated. Furthermore, supported by the CAT tool, the ASM operator was able to select, visualise and analyse the DMAs. Furthermore, the CAT tool provided to the ASM operator means to modify and propose to the WOC the optimal conflict-free location for the DMA type 1 and type 2 that minimizes impact on DAC capability to accommodate the traffic demand.

In support of civil-military CDM, a ‘what-if’ capability provided by the CAT tool facilitates the assessment and comparison of different solutions for the DMA type 1 and type 2 as well as for TTO/iMT. At this stage, the CAT tool also enables the integration of ATFM information allowing the ATFM operator to create, manage, visualize, and share ATC volumes and TTO proposals with the WOC.

In the validation exercise, it was also proven the support of the relevant tools to a dynamic sharing and updating of iMT with DMA type 1 and type 2 data set amongst concerned actors. The WOC-MT tool automatically generates the description of MT profile with integrated DMAs as allocated in the ASM process and the resulting iOAT FPLs.

5.4 Performance benefits expectation

The performance assessments performed during the validation exercise reflect the following performance expectations:

5.4.1 Performance expectations for the military airspace user

The military mission effectiveness is safeguarded throughout the new operating methods for mission trajectory development with integrated DMA of types 1 and 2.

Furthermore, the solution contributes to improved use of airspace capacity with equal benefits to ATM performance needs for traffic demand accommodation and the military operational requirements.

Performance expectations:

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- 100% satisfaction to DMA user request for training time inside airspace reservation/restriction.
- 100% satisfaction to DMA user request for volume of airspace allocated to training inside airspace reservation/restriction.
- reduction of transit time proportion relative to the total mission duration.
- improvement could be expected concerning the time available for training inside airspace/reservation restriction after the optimization of MT profile. This enforces the results of airspace capacity assessment results.

5.4.2 Performance expectations for ANSPs

The optimization of DMAs throughout a dynamic civil-military CDM enables the reduction of airspace segregation impact on the deviations to planned FRA trajectories (up to 60% in the local airspace scenario and 39% at ECAC level), hence likely improving the capability to adjust and balance the distribution of traffic amongst ATC sectors. Furthermore, the application of planning time constraints -TTO- to mission trajectory supports integrated ASM-ATFCM measures to alleviate ATC sector capacity issues.

The implementation of the solution could boost the local airspace capacity by 2,07%. The results need to be seen from the perspective of a standing ATC sector configuration used during the validation. The experts consider that a joint optimization of DMA and ATC sector configuration could maximise the potential benefit of the solution to airspace capacity.

5.4.3 Performance expectations to civil airspace users

The implementation of mission trajectory with DMA of types 1 and 2 could have a significant positive benefit on intra ECAC cross-border flights. However, the exercise validation results reflect a possible solution benefit of 6 minutes (6%) reduction in average per flight of the impact of airspace reservation/restrictions.

5.4.4 Performance expectations to Environment

The implementation of the solution contributes to the reduction of CO2 emissions as a result of improved fuel efficiency for en-route operations. The 0,2% benefit expectation to fuel saving and CO2 emissions resulting from the validation exercise could be significantly improved if a cross border validation scenario for mission trajectories with DMA of types 1 and 2 is assessed.

5.4.5 Safety performance expectations

The changes brought by the solution does not affect directly ATS services (no direct impact on the way ATCOs and Pilots act, interact and make use of tools/equipment in view of delivering ATS), but rather focuses on the planning phase of the management of the integrated civil-military ATM demand – therefore, services delivered to civil and military AU and ANSPs prior to the execution phase.

The number of conflicting trajectories within FRA could be reduced by 15% leading to the expectation of reduced safety risks to both airspace users and ATCs.

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By rerouting fewer aircraft, the workload of the controllers could also be less impacted by the changes imposed by the military activities, and consequently the safety will be improved.

5.4.6 Human Performance impact expectations

Changes in WOC human actors' tasks are expected as they will participate in a CDM process with the sub-regional / local ASM / ATFCM processes by submitting initial MT/DMA requests and refining these as they mature and move closer to the time of operations.

Changes in ASM human tasks are expected as they will consider the DMA request associated with the MT and participate in the DMA booking request refinement.

Changes in ATFCM human task are expected as they will participate in the sub-regional / local MT impact assessment, associated DCB solution development, apply what-if capabilities for DMA location optimisation and submit change proposal to WOC.

The allocation of tasks between the human and tools is expected to change due to implementation of automation support to human decisions and interdependencies in the overall MT/DMA impact assessments and negotiations.

The dependencies involved in the impact assessment would place significant cognitive requirements on the human actors and are suitable processes for automation. Human actors will be required to resolve unforeseen situations and to make the final decision and therefore they need a good understanding of the processes, procedures and other stakeholders' needs and requirements.

The new operating method increases and improves communication between the roles and stakeholders through improved system support ensuring all stakeholders are informed of the state and status of the negotiation process.

Assuming sufficient level of technical support is available, the acceptance of new roles and responsibilities can be expected to be high and job satisfaction is expected to increase for the ASM and ATFCM human actors as they now have more timely and accurate information available for the execution of their tasks. Workload impact should be manageable.

5.5 Military views

The military experts consider that DMA type 1 and 2 do not represent the only operating method for supporting future military airspace requirements as other types of airspace reservations (static, VPA) will be still required by the nature of missions.

However, the solution provides a practical starting point for the implementation of the flexibility and dynamicity of the processes related to the management of airspace reservations in the future European ATM.

Furthermore, DMA types 1 and 2 are seen as a good basis for further developing the concept element of DMA type 3.

The key requisite for the implementation of the new roles and tasks and the shift of activities from strategic to pre-tactical ASM level is a strategic level ASM-ATFCM framework elaborated at State level in coordination with the Network Manager. It should establish the roles, responsibilities,

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competences and negotiation procedures to enable the flexibility of proposed processes and the negotiation of airspace structures configuration throughout civil-military CDM.

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6 Recommendations and Additional activities

The following recommendations are relevant to further activities addressing mission trajectories with DMA of types 1 and 2 as well as once transitioned to industrialization (V4).

6.1 Operational

6.1.1 For the next phase (V4) of solution 40 validation

- Further address the applicability of DMA types 1 and 2 within a Very Large-scale Demonstration (VLD) for complex missions in different operational environments (i.e. cross border missions with different types of task and various national users as well as combined usage of DMAs).
- Thoroughly address the safety assessment of the DMAs throughout different use cases applied to the operating methods.
- The validation scenarios for next validation steps should be conducted based only on the information provided by the WOC ASM tool (e.g. the timeline and the nature of the mission) and not by a description provided in advance to the participants. The scenarios should contain non-nominal/degraded situations that are described in use cases and the validation plan, and further translated into requirements.
- The solution envisages a shift of competencies in airspace reservation/restriction design from the ASM policy to the pre-tactical level. The next phase of the solution validation should provide a generic list of competencies to be shifted to enable the impact of solution deployment on the current ASM arrangements at national levels.
- The quick ATM system reaction needed for short-notice requests could be hampered by the complexity of impact assessments related to TTO. A more complex scenario for short-notice military requests should be checked in order to have a clearer view on TTO applicability for this case.
- The performance expectation concerning the contribution of iMT with integrated DMA of types 1 and 2 to predictability (PRD) and time efficiency (TEFF) should be confirmed throughout a VLD with cross-border missions scenario.

6.1.2 For the next cycle of SESAR solutions addressing the MT concept

- Address the association and viability of priorities to MT with integrated ASM elements (airspace reservations of all types) and the modalities for definition, sharing, and processing at national and network level.
- Further investigate the complexity of TTO/iMT negotiation with actors not involved in this solution (i.e. crews, network manager) is required in the next validation phase of the MT concept. Military WOC operators consider that for more complex real-life missions, TTO negotiation will increase the complexity of impact assessments on mission effectiveness, hence the applicability

will need to be assessed case by case. Alleviation of complexity could be enabled by the implementation of MT priorities by future SESAR solutions addressing MT.

- Address the sharing and processing of DMA flexibility within the NM systems and processes once they are allocated at national level and fully integrated into the description of MT as provided by the OAT FPL.
- Considering the national prerogative over airspace reservations, the role of NM in the management of DMAs needs to be further elaborated.
- Further investigate the impact of the DMA type 1 and 2 concept in the tactical phase (MT execution).
- Develop and validate the concept of DMA type 3 by building upon the flexibility and dynamicity provided by DMA type 1 and 2 processes and tools.
- The full implementation of civil-military CDM at national level will need to consider the impact on different roles involved in DMA changes: mission planner, pilot/crew, decision-maker as well as the role of the network manager.
- The green SWIM profile should be considered in the development of the Mission Trajectory concept, specifically in the next cycle of related validations addressing the interactions of WOC with network level actors.

6.2 System support

- With the proposed tool prototypes, in WOC there is no technical support for the visualisation of the flexible parameters for the MT with integrated DMAs (available only in the ASM tools) when TTO is introduced into the negotiation process. For the WOC operators it would be useful to have a set of flexible parameters also for MT (e.g. suitable entry or exit points).
- In case of the dependency of different DMAs (i.e., when multiple DMAs are linked to a trajectory or when one DMA is linked to multiple trajectories), the information should be contained in the description of such DMAs within an aggregated HMI in WOC (preferably graphical visualization of impacted DMAS and trajectories) in order to improve the efficiency of the negotiation process.
- The service supporting the information exchange between ASM/DAC and WOC tools on DMA data set as well as the HMI of the tools need to be upgraded in order to provide the operators the possibility to visualise the specific changes during the CDM and not the whole DMA data set.
- The WOC MSS (Mission Support System) should provide a fully integrated ASM and MT tools interface supporting the assessment and negotiation of changes to both ASM and trajectory profile elements.
- An HMI support should be provided in WOC allowing comparison of the trajectory(ies) recalculated with TTO proposal with the initial one(s) (i.e., automatic recalculation and visualization of the new trajectory based on the TTO input).
- The WOC ASM tool to be upgraded to provide an automatic recalculation of the DMA parameters changed by the application of TTO.
- The WOC tool HMI should allow to rotate the DMA in order to have more visibility of the changes. Currently the rotation is only available through modification of coordinates.

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- The CAT tool should provide the support to automatically identify/ pre-select optimal areas for airspace volumes so that to better support the assessments of the operators.

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7 Actors impacted by the SESAR Solution

Actor	Involvement	Why it matters to stakeholder
Military / State AU (WOC)	AU and a primary beneficiary of MT and A-FUA implementation. Focused on avoiding any negative impact of the solution on the effectiveness of military mission.	Expectation: • enhance the flexibility of the ATM system to accommodate military ATM requirements including for short notice requests/changes (FLX) • access to the required airspace and flight profile suited to mission planning, throughout civil-military CDM, which balances between the given specific mission requirements and the performance expectation needs of the ATM system (CMCC) • upgrade of WOC mission support systems to process properly the initial MT information integrated with DMAs of types 1 and 2 (CMCC)
ANSP	Primary beneficiary of A-FUA implementation for the delivery of ASM and ATFM functions at sub-regional/local level. Mainly concerned by improved accommodation of traffic demand and compliance with performance targets.	Expectation: • En-route capacity planning is improved thanks to a better management of traffic complexity enabled by the flexibility and dynamicity of DMAs of types 1 and 2 (CAP2) • improved traffic predictability in planning phase through the integration of shared MT, into the analysis and mitigation measures of traffic complexity (PRD1) • the flexibility of the ATM system is enhanced to accommodate civil and military ATM planning constraints and preferences/priorities (FLX)
Industry	Provider of technical systems and tools. Mainly interested in maximizing the usage of technical support outputs by operational processes.	Expectation: • concept and processes support practicable system and tool development • the prototypes are cost-effective and further industrialized
Network Manager	Interested in the implementation of the solution as close as possible to the requirements for the delivery of the regional ASM and ATFM functions.	Expectation: • effective cooperation between all the stakeholders in moving towards an optimised airspace configuration • improved efficiency of sub-regional/local ASM-ATFM and military requirements based on CDM
Civil Airspace User	Directly affected by the implementation of the solution. Concerned by improved accommodation of GAT demand and preferences.	Expectation: • increased efficiency of flights • more flexible use of airspace structures
European Commission	Participation through SJU in the coordination and monitoring of the activities for the implementation of the solution. Concerned by the adherence of the solution to apportioned ATM performance targets.	Expectation: • Particularly interested in costs and performance benefits to KPA's capacity, environment, operational efficiency, and flexibility

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8 Impact on Aircraft System

N/A

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9 Impact on Ground Systems

The implementation of the operating methods validated by the solution requires upgrades to the ground system capabilities supporting the definition and management of mission trajectories with DMA of types 1 and 2, impacting the functions of all relevant actors engaged.

The following new technical features needs to be considered:

- Automatic support, minimum 'what-if' capability' necessary to facilitate impact assessments and decisions concerning the integration of DMA definition and allocation in both mission trajectory development and airspace configuration processes and systems.
- New features to support the definition, management, and negotiation (through CDM processes) of the integrated military ATM demand composed of iMT 3D profile and DMA Type 1 and 2 whilst taking on board the static areas as well.
- Adequate automatic support necessary to implement new operating methods with focus on the development the iMT data set (from early flight intent to iSMT) and DMA flexible parameters (e.g. activation time, location, time over entry point, and flight level band) with associated thresholds.
- Development of new features to support the level of priority associated to a DMA to define constraints related to specific parameters.
- Development of new features to support the modification of the mission trajectory applying the concept of TTO (Target Time Over point) to respond to, either military mission requirements or airspace capacity optimization needs.

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10 Regulatory Framework Considerations

At this stage of R&D activities there are regulations identified to be subject of updates.

The current Commission regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace covers the operating methods and procedures proposed by the solution.

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11 Standardization Framework Considerations

At this stage of R&D activities there are no standards identified to be subject of updates and/or changes following to the V3 validation.

From and operational perspective, the results of the validation should be considered in the industrialization phase of R&D activities, specifically for the domain airspace and procedures.

The industrialization phase results should provide inputs to:

- EUROCONTROL Publication for harmonised Rules for OAT under IFR inside controlled Airspace of the ECAC Area[1]

- ERNIP Part 3 - Procedures for Airspace Management, Airspace Management Handbook for the Application of the Concept of the Flexible Use of Airspace[2]

The following documents provide standards applicable but not require updates/changes:

- ICAO Doc 4444 ATM/501 (ATS message type 'FPL'), last version available.

- Eurocontrol IFPS Users Manual, last version available[3]

- Eurocontrol IFPS and RPL Dictionary of Messages, last version available[4]

- EUROCONTROL Specification for Airspace Management (ASM) Support System Requirements supporting the ASM processes at local and FAB level

- ICAO Manual on system wide information management (SWIM) concept, Doc 10039 AN/511

- AIXM 5.1 - XML Schema (XSD)

[1] Document systematically updated

[2] Ibid1

[3] Ibid 1

[4] Ibid 1

12 Solution Data pack

The data pack for Solution PJ07-W2-40 includes the following documents:

- Regulatory overview (developed by S3JU)
- D4.1.004_PJ07W240_ Final_V3_SPRINTOSED_ part I_ed.01.00.01_16Nov22
- D4.1.004_PJ07W240_Final_V3_SPRINTOSED_part II_SAR_ed.00.00.04_10Nov22
- D4.1.004_PJ07W240_Final_V3_SPRINTOSED_part IV_HPAR_ed.01.00.00_09Nov22
- D4.1.004_PJ07W240_Final_V3_SPRINTOSED_part V_ PAR_ed.01.00.01_04Nov22
- D4.1.005_PJ07-W2-40 Final_V3_ TS IRS_ed.01.00.02_06Dec22
- D4.1.007_PJ07W240_ Final_V3_ VALR_ed.00.00.06_09Nov22
- D4.1.006_PJ07-W2-40_V3_CBA_ed.01.00.01_11Nov22

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