Final Project Report

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Abstract

P07.05.04 addressed the Advanced Flexible Use of Airspace topic with the objective to provide more flexibility by allowing dynamic airspace management in all phases of the operations, from initial planning to the execution phase, taking into account local traffic characteristics. In this context, P07.05.04 validated the SESAR Solution #31 (ATM functionality AF#3-1 of PCP) including new ARES design principles, real-time airspace status data exchange, their integration into national ASM systems and its automated communication links between ASM, ATFCM and ATC actors and systems at local, regional and sub-regional levels. P07.05.04 also addressed the Dynamic Airspace Configuration concept which integrates AFUA developments in Trajectory Based Operations with regards to DCB and airspace configurations management, and the integration of Dynamic Mobile Areas (DMA) in DAC.

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Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
ACC	Area Control Centre
AF	ATM Functionality
AFUA	Advanced Flexible Use of Airspace
AIRM	ATM Information Reference Model
AIXM	Aeronautical Information Exchange Model
AMC	Airspace Management Cell
ANSP	Air Navigation Service Provider
ARES	Airspace Reservation/Restriction
ARN	ATS Route Navigation
ASM	Airspace Management
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATS	Air Traffic Services
AU	Airspace User
AUP	Airspace Use Plan
B2B	Business to Business
CBA	Cost Benefit Analysis
CDM	Collaborative Decision Making
CWP	Controller Working Position
DAC	Dynamic Airspace Configuration
DCB	Demand Capacity Balancing
DCT	Direct (route/s)
DMA	Dynamic Mobile Area

DS	Data Set
ECAC	European Civil Aviation Conference
FIR	Flight Information Region
FL	Flight Level
FMP	Flow Management Position
FOC	Flight Operations Centre
FRA	Free Routing Airspace
FRAMAK	Free Route Airspace Maastricht and Karlsruhe
FTS	Fast Time Simulation
HMI	Human Machine Interface
INTEROP	Interoperability Requirements
ISRM	Information Services Reference Model
KPA	Key Performance Area
KPI	Key Performance Indicator
NM	Network Manager
NMOC	Network Manager Operations Centre
NOP	Network Operation Plan
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PCP	Pilot Common Projects
RTS	Real-Time Simulation
RTSA	Real Time Status of Airspace
SA	Situational Awareness
SAM	Sharable Airspace Module
SBB	Sector Building Block
SESAR	Single European Sky ATM Research Programme
SPR	Safety and Performance Requirements
SWIM	System Wide Information Management

TRL	Technical Readiness Level
UIR	Upper Information Region
UPR	User Preferred Routing
VPA	Variable Profile Area
WOC	Wing Operation Centre
WP	Work Package

1 Project Overview

The main goal of this project was to develop and validate within Time Based Operations context the Advanced Flexible Use of Airspace concept based on a new Airspace Reservations (ARES) design principle (called Variable Profile Area - VPA -) and on the real-time airspace status data exchange as well as their integration into national ASM system and its automated communication links between ASM (AirSpace Management), ATFCM (Air Traffic Flow and Capacity Management) and ATC (Air Traffic Control) actors and systems at local, regional and sub-regional levels. In the context of Trajectory Based Operations, P07.05.04 developed the Dynamic Airspace Configuration (DAC) concept enabled via the incorporation of Complexity Management into the DCB process with intention of allowing for the opportunity to provide an automated support mechanism to optimise airspace configuration based on “Predicted Workload”. P07.05.04 also worked on the DMA (Dynamic Mobile Area) integration in DAC after Airspace Users share their planning (airspace demand).

The following organisations contributed to the project: DFS, DSNA, ENAIRE, ENAV, EUROCONTROL, INDRA, NATS, NORACON, LEONARDO (SELEX), THALES

1.1 Project progress and contribution to the Master Plan

In the Time Based Operations context, SESAR Project P07.05.04 "Flexible Airspace Management" was focused mainly on two Operational Improvements in the pipeline towards deployment in the ATM Master Plan:

- Flexible and modular ARES in accordance with the VPA design principle: OI AOM-0206-A / SESAR Solution #31
- Automated Support for strategic, pre-tactical and tactical Civil-Military Coordination in Airspace Management: OI AOM-0202-A / SESAR Solution #31

In support to other projects, P07.05.04 also contributed to validate the following other Operational Improvements:

- Collaborative NOP: OI DCB-0103-A / SESAR Solution #20 (P07.06.01).
- Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high & very high complexity environments: AOM-0500 / SESAR Solution #65 & Solution #32.
- Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments: AOM-0501 / SESAR Solution #33 (P04.03)

It has to be noted that Solutions #20, #32, #33 and #65 will be deployed in accordance with the Pilot Common Projects.

Variable profile military reserved areas and enhanced (further automated) civil-military collaboration (Solution #31)

Solution #31 consists of:

- The Variable Profile Area design principle based on flexible allocation and management of small fixed predefined modules of airspace. These modules are designed to fulfil airspace users’ needs individually or as a combination of modules as an ARES, dependant on individual mission profiles. The VPA modules are requested by the military airspace user and negotiated with the Airspace Managers through a CDM process. The objective is to offer greater flexibility to accommodate military requirements by defining different airspace scenarios with acceptable network impact through extension or sub-division of military training areas adjusted to match the military training and operational requirements.
- The real-time sharing of airspace status amongst all ATM actors such as the Network Manager Operations Centre (NMOC), Airspace Managers, Flow Management Positions (FMPs), ATC controllers, Airspace Users (Flight Operations Centres (FOC) and Wing Operations Centres (WOC)) allows Airspace Users to update their flight plans in real-time, so

as to take advantage of the early release of airspace from the military. With timely information on airspace status, Airspace Users can reassess and optimise their trajectories so maximising usage of available airspace.

Solution #31 has been validated through a series of activities including Fast Time Simulations, Real Time Simulations, and Live Trials, focusing on a range of objectives from the validation of the VPA design principle in different airspaces, in a route network environment and in a free route airspace to the distribution of the real-time status of airspace to all involved ATM stakeholders, via systems interconnections, and the display of this status on ATC systems ensuring the process is safe.

Fast-Time Simulations have been used:

- To address VPA design principle and network impact assessment for different airspaces, in a free route environment (with Low to Medium complexity) and in an ATS route as well, validating the use of modular ARES and the benefits provided for civil and military users.

Real-Time Simulations allowed to:

- Demonstrate the feasibility and benefits of updating the real-time airspace status automatically into the NM systems, delivering a closed CDM process loop between ASM Support Systems, NM systems and ATC system and thus to make better use of available capacity.
- Demonstrate the interoperability between the ASM, NM, FOC and WOC systems. The RTSA have been distributed and processed among the ATM actors concerned. This RTSA data has been used by the involved actors in order to provide their own impact assessments and facilitate a new flight planning cycle for the re-routing of the eligible flights to take advantage of early release of airspace or to avoid a newly reserved area. The involvement of FOC/WOC in validation activities confirmed the strategic significance of the airspace users' participation in AFUA.

And live trials allowed to:

- Addressed the integration of VPA in the Network and network performance improvement by sharing in real-time the airspace planning and its status.
- Validate the automated process of activation and/or deactivation of ARES in ATC systems by interfacing an ASM Support System with ATC systems. It also demonstrated operational and technical feasibility of the automatic update of ATC systems with RTSA via ASM Support Systems, and the safety of this process.

Dynamic Airspace Configuration (DAC)

In the Trajectory Based Operations context, P07.05.04 initiated the validation of the Dynamic Airspace Configuration concept at the V2 maturity level for the OI's AOM-0805, AOM-0208-B, AOM-0809 and AOM-0502. The challenge is to organise, plan and manage airspace configurations to meet User Preferred Routing, in a Free Route environment -- or not -- with enough flexibility to respond to any change in traffic demand, to any unexpected event including weather, and to any update in airspace reservation within AFUA concept in the optimum way, while maintaining the safety targets.

Four levels of DAC level dynamicity have been identified in the concept as follows:

- DAC Level-1 is the lowest level of airspace adaptability. Instead of using predefined sectors configuration, Level-1 uses dynamically computed configurations by combining existing elementary sectors provided by an automated optimization process.
- DAC level-2 increases the adaptability of the airspace to the traffic pattern by delineating from the nominal sectors, a limited number of airspace components that can be recombined laterally and/or vertically within an automated and optimized sector configuration process to form controllable airspace blocks.
- DAC level-3 increases adaptability with smaller entity defined by a less structured traffic pattern but their workability as a separate entity is not ensured.
- DAC Level-4 contains no more predefined airspace component known and full generic ATC validation is a prerequisite for the implementation of this level.

Validation activities allowed the validation of initial operational feasibility of the concepts of Sector Building Block (SBB) and Sharable Airspace Module (SAM) allowing the different DAC levels and of algorithms to automate the definition of Dynamic Airspace Design and Configurations responding in a flexible manner to Airspace Users' needs.

The DMA specifications and the description of interactions between DAC and DMAs (type 1 and 2) have been initiated from a concept point of view but not validated yet.

Operational Improvements and Enablers

The following lists the Operational Improvement steps and the Enablers linked to P07.05.04 activities within "Time Based Operations" context (and especially Solution #31 "Variable profile military reserved areas and enhanced (further automated) civil-military collaboration") as well as within Trajectory based Operations context.

The Operational Improvement steps and the Enablers used in this document are with reference to the Integrated Roadmap DS-15.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AOM-0202-A	Automated Support for strategic, pre-tactical and tactical Civil-Military Coordination in Airspace Management (ASM).	P07.05.04 developed, validated and provided recommendations on this OI step for V4 phase. This OI is covered in OSED, SPR, INTEROP and TS documents. The validation activities have been executed through five different exercises VP-015, VP-016, VP-017, VP-710 and VP-717 to reach the V3 maturity level.	V2	V3
AOM-0206-A	Flexible and modular ARES in accordance with the VPA design principle	P07.05.04 developed, validated and provided recommendations on this OI step for V4 phase. This OI is covered in OSED, SPR and INTEROP documents. The validation activities have been executed through five different exercises VP-015, VP-016, VP-017, VP-710 and VP-717 to reach the V3 maturity level.	V2	V3
AOM-0500	Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high & very high complexity environments.	The exercise VP-571, performed under Project 07.05.04, complemented by the large scale demonstration FRAMAK addressed the feasibility of direct routing in the core area (MUAC airspace). In 2015 6 FIR/UIR operate DCT H24 in Europe.	V2	V3
AOM-0501	Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments	The main contribution was delivered through the exercise VP-465 that investigated user preferred routing effects on: Fuel efficiency/environment, predictability and network management/flight	V2	V2

		Planning. 07.05.04 supported 04.03 for the V2 real-time simulation VP-797 led by Skyguide by assessing the network impact of user preferred trajectories provided by WP11.01 and by simulating the flow management process (regulated traffic) for different scenarios (FRA minimum FL, weather conditions, military ARES activation and type of waypoints published only or Lat/Long). In 2015 this solution is in operations H24 (might be level restricted or on seasonal basis) in various parts of Europe (Ireland, Denmark, Sweden and Portugal).		
AOM-0208-B	Dynamic Mobile Areas (DMA) of types 1 and 2	P07.05.04 contributes to provide the DMA specifications meaning DMA information needed by the relevant actors for planning, sharing, execution and performance assessment. It also describes DMA interactions with the DAC concept. P07.05.04 contributed to bring the PRO-146 enabler to early V2 maturity level.	V1	Early V2
AOM-0809	Sector Design and Configurations Unconstrained by Predetermined Boundaries	P07.05.04 developed this OI through the DAC concept in Trajectory Based Operations context and validated it to V2 maturity level thanks to exercises VP-718 and VP-755. P07.05.04 contributed to bring the NIMS-04 enabler to early V2 maturity level.	V1	Early V2
AOM-0805	Collaborative Airspace Configurations	P07.05.04 developed this OI through the DAC concept in Trajectory Based Operations context and validated it to V2 maturity level thanks to exercises VP-718 and VP-755.	V1	Early V2
DCB-0103-A	Collaborative NOP	Contribution through two exercises: one linked to the integration of VPA in the network and network improvement by sharing in real-time airspace planning and status, addressing Level 2 of ASM and the other to the sharing of real-time status of airspace in execution phase.	V2	V3
AOM-0502	Free Routing for Flights both in cruise and vertically evolving within high & very high-complexity environments	P07.05.04 developed this OI through the DAC concept in Trajectory Based Operations context and validated it to V2 maturity level thanks to exercises VP-718 and VP-755.	V2	V2

AAMS-06b	ASM support systems enhanced to exchange static data and airspace usage data with NM systems in AIXM format.	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercise VP-016. Static environment data and airspace usage data have been exchanged between ASM support systems and NM systems in AIXM format.	TRL4	TRL6
AAMS-06c	Local ASM Tools to be updated to support Transmission of VPA-related data from local ASM tool to the NM.	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercises VP-016 and VP-710. VPA related data have been exchanged between ASM support systems and NM systems.	TRL4	TRL6
AAMS-09a	NM systems enhanced to exchange static data and airspace usage data with ASM support systems in AIXM format.	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercises VP-016 and VP-710. Static environment data as well as airspace usage data have been exchanged between NM systems and ASM support systems.	TRL4	TRL6
AAMS-11	ASM support systems enhanced to exchange real-time airspace status updates	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercises VP-017 and VP-710. Real-time airspace status data (including updates) have been exchanged between ASM support systems and both NM & ATC systems.	TRL4	TRL6
ER APP ATC 77	ATC systems enhanced to exchange real time (tactical) airspace status data with ASM support system.	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercises VP-017 and VP-710. Real-time airspace status data (including updates) have been exchanged between ATC systems and ASM support systems.	TRL4	TRL6
MIL-0502	Upgrade of military ground systems to allow bi-directional exchanges with non-military IP networks	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercise VP-710. Airbus Defence & Space systems have been able to exchange information with NM and ASM support systems over non-military IP networks	TRL4	TRL6

NIMS-42	NM systems enhanced to receive, process and display real-time tactical (ASM level III) airspace usage information	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercise VP-710. NM systems received (from ASM support systems), processed and displayed real-time airspace status data.	TRL4	TRL6
PRO-011	ASM Procedures to ensure that the change in airspace availability is promulgated through SWIM and reflected in the NOP	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercise VP-710. Real-time airspace status data shared by ASM support systems have been promulgated via B2B services and reflected in the NOP following defined ASM procedures.	TRL4	TRL6
PRO-024	ASM Procedures related to real-time (tactical) ASM level III information exchange	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to validate this technical enabler to TRL6: exercise VP-710. Real-time airspace status data shared by ASM support systems have been promulgated via B2B services and reflected in the NOP following defined ASM procedures.	TRL4	TRL6
SWIM-APS-03a	Provision of ATFCM Information Services for Step 1	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-710.	TRL4	TRL6
SWIM-APS-04a	Consumption of ATFCM Information Services for Step 1	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-710.	TRL4	TRL6
SWIM-STD-01	AIRM	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-710.	TRL4	TRL6
SWIM-STD-02	ISRM Rulebook	Developments undertaken validation activities of OIs AOM-0202-A and AOM-0206-A allowed to contribute to validate this technical enabler to TRL6: exercise VP-710.	TRL4	TRL6

1.2 Project achievements

Variable Profile Areas and enhanced civil-military collaboration

P07.05.04 validated SESAR Solution#31 which reached V3 maturity level for SESAR Release 5. The solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project (ATM sub-functionality AF#3-1).

P07.05.04 validated the VPA design principle in different airspaces, in a route network environment and in free route airspace (with Low to Medium complexity). It allowed defining interoperability requirements to interface ASM support systems with NM systems in order to automatically provide the static airspace and Airspace Use Plan (AUP) data to the network managers and the FMPs.

P07.05.04 validated the distribution via B2B services in AIXM format of the real-time status of airspace to all involved ATM stakeholders, and the display of this status on ATC systems ensuring the process is safe. It also validated the automated process of activation and/or deactivation of ARES in ATC systems by interfacing an ASM Support System with ATC systems. It also demonstrated the automatic update of ATC systems with RTSA via ASM Support Systems, and the safety of this process.

The main findings from the overall validation exercises can be summarised as follows:

- VPA reduces fuel burnt by civil flights in order to fly around active ARES while at the same time ensuring that military needs are fulfilled,
- The value and scale of benefits depend on the specificity of VPA configuration, which should be designed in order to minimize the number of conditional routes blocked when active,
- To fully exploit the VPA design principle, conditional routes and variable profile areas should be complementary designed,
- RTSA increases situational awareness both for Airspace Users providing opportunities for civil flights to benefit from early released ARES and to reduce the negative impact of ad-hoc activated ARES and more generally, for all ATM stakeholders by reducing uncertainty and misinterpretation of current airspace status information.
- RTSA facilitates the cross-border operations and the CDM process.

Dynamic Airspace Management

Validation activities have been concentrated on initial operational feasibility of the automated tools to support the design and management of the airspace and on initial quantitative performance measurements of the relevant KPAs and KPIs attributed to Dynamic Sectorisation and Constraint Management.

There is evidence of general high-level operational acceptance by operational staff of the DAC concept. Most of the principles considered in sector design at DAC level 1 and 2 were considered important by the experts.

Automated supporting tools' principles and associated processes have been accepted by the experts for each DAC level. The experts believe that the tool supporting sector design for DAC level 1 would have a positive or even very positive impact both in ARN as well as in FRA airspaces. The same conclusion has been drawn for the sector configuration builder and sector opening scheme optimizer at each level of adaptability. Improvements for these tools have been identified.

Regarding the configuration's duration, the majority of the experts believe that the minimum duration of a sector configuration should not be less than 30 minutes at each DAC level (1, 2 and 3). Shorter duration can be considered but it depends on ACC and ATC system support availability.

Clear impact of Human Performance (e.g. situational awareness, training) has been identified and further validation work is required to investigate this area. Most experts expressed in their feedbacks that changes in DAC Level 2 and, even more, in Level 3, would present challenges to build and/or maintain Situational Awareness (SA), and that the actual impact of the methodology on SA would depend much on CWP supporting tools. Most experts believe that an adapted training (42% for a

drastic change, and 50% for a small change in trainings) is necessary to allow ATCOs being ready to cope with change in shape induced by the additional or removal of SAMs. Regarding the role of human vs automated tools, the proposed processes which enable the human operator to evaluate, select and modify the sector design, sector configurations and sector opening schemes generated by the automated functions in tactical or pre-tactical phase were accepted by the experts.

The quantitative results demonstrate clear benefits regarding the different KPAs, mainly workload distribution.

Impact on Capacity was assessed and it was concluded as positive at each DAC level for both ARN and FRA environment. Quantitative assessment demonstrates a benefit on Capacity that increases with an increasing DAC adaptability level.

Impact on Cost-efficiency was assessed through expert group and the majority of experts envisioned a positive impact at each flexibility level on cost-efficiency. Fast-time simulation showed a more neutral impact (or slightly positive) of cost-efficiency at each adaptability level. Quantitative assessment of cost-efficiency concluded on a neutral impact of DAC concept at each adaptability level. Only DAC level 3 demonstrates a slight reduction of controller hours due to the generation of new sector configurations; further assessments should be done regarding Safety and Human Performance.

Impact on Fuel-efficiency was assessed through expert group and the majority of experts believe in a positive or neutral impact.

The majority of experts (58%) think that further research is required to ensure safety aspects related to the design of new sector boundaries covered by the DAC concepts.

It has been demonstrated that in most of the cases DMA type 1 has a negligible impact on civil fuel consumption compared to the situation when no ARES is activated while allowing the military mission to be successfully completed.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D56	SPR Step2-V2 v1.0	This Safety and Performance Requirements (SPR) document provides the safety and performance requirements for Services related to the operational Processes defined in Dynamic Airspace Configuration Step 2-V2 OSED in the “trajectory based operations” context.
D66	Validation Report DAC S2 V2 v1.0	This Validation Report describes the results of validation exercises VP-715 & VP-755 for Dynamic Airspace Configuration concept at V2 maturity level in the “trajectory based operations” context
D54	OSED Step2 V2 v 3.0	This Operational Service and Environment Description document develops the Dynamic Airspace Configuration concept for V2 maturity level assessment that forms the basis for all elements of Dynamic Airspace Configuration operations including advanced Flexible Use of Airspace concept elements in the “trajectory based operations” context.
D52	Validation Report Step 1-V3 v3.0	This Final Validation Report presents the results of the validation activities (exercises VP-015, VP-016,

		VP-017, VP-710, VP-717) for Advanced Flexible Use of Airspace concept in the "time based Operations" context. It allowed to asses to V3 maturity level the SESAR Solution #31 and provided associated conclusions & recommendations.
D46	INTEROP V 3 step 1-V3 v2.0	This Interoperability requirements document for Advanced Flexible Use of Airspace in the "time based Operations" context provides the interoperability requirements for the processes and services described in the D45 OSED document by describing the ground-ground interfaces and data exchange between ASM support systems, the Network Manager and the ATC system to support the ASM/ATFCM processes in all phases. It contains interoperability requirements associated to SESAR Solution #31.
D45	OSED V3 step 1-V3 v2.0	This Operational Service and Environment Description for Advanced Flexible Use of Airspace document develops, within in the "time based Operations" context, operational requirements supporting the "Flexible and modular ARES in accordance with the VPA design principle" and "Automated Support for strategic, pre-tactical and tactical Civil-Military Coordination in Airspace Management" operational improvements. It contains operational requirements associated to SESAR Solution #31
D47	SPR V3 Step 1-V3 v2.0	This Safety and Performance Requirements document provides, within in the "time based Operations" context, the safety and performance requirements for Services related to the operational Processes defined in D45 OSED. It identifies the requirements needed to fulfil each Key Performance Area (KPA). It contains safety and performance requirements associated to SESAR Solution #31.
D49	Technical specification Step 1-V3 v1.0	This Technical Specifications document specifies the behaviour of the ATC system, ASM support systems and the NM system in relation of the dynamic booking of the airspace structure (ARES) within "time based Operations" context, its visualisation on the ATC system (CWP) and the opportunity to make available the information to other partners (FOC, WOC, AMC) for whom the update of planning data may be relevant and, consequently, used to support the decision making process between FOC/WOC, AMC and NM actors. It contains technical requirements for systems part of SESAR Solution #31
D33	OSED Step 1 V3	This Operational Service and Environment Description document describes the principles behind User Preferred Routing in order to allow

		Airspace Users to fly their preferred business trajectories without the need to adhere to a predefined route structure. It is related to operational improvement AOM-0501 on free routing.
D03	INTEROP Step1 V3	This Interoperability requirements document for User Preferred Routing operations in the "time based Operations" context provides the interoperability requirements for the processes and services described in the D33 OSED document. It covers the interoperability between an ASM tool and the different Air traffic management (ATM) systems.
D35	Final VALR Step1 V3	This Validation Report describes two activities largely based on free routing initiatives already on-going within ECAC area that contribute to the validation of User Preferred Routing concept: • Free Routing MUAC - a Real Time Simulation (RTS) investigating and simulating specific UPR scenarios by using DCT routing between published entry/exit waypoints; • Free Routing Live Trial in Northern European airspace - a Live Trial investigating the feasibility of UPR in Northern European airspace, including cross-border and cross-FAB operations.

1.4 Contribution to Standardisation

The work in the project did not produce standards on its own but the content of the RTSA data message from SESAR Solution#31 shall be integrated in AIXM 5.1.

P07.05.04 participated in the identification of relevant SWIM services for AFUA-ARES and SWIM services relevant to NOP services

1.5 Project Conclusion and Recommendations

Variable Profile Areas and enhanced civil-military collaboration

Conclusions

Benefits in term of fuel consumption reduction of VPA design principle while allow military to achieve their mission objectives has been demonstrated.

The RTSA exchange showed clear benefits in terms of SESAR KPAs, mainly fuel savings (environment efficiency) by providing opportunity to civil flights to benefit from early released ARES and to reduce the negative impact of ad-hoc activated ARES. It also contributed to civil and military cooperation & coordination with more oriented AUs and facilitated the cross-border operations and the CDM process.

The concept of the RTSA update was very favourably accepted by the different actors (Network Manager, AMCs, Airspace Users, WOC, FOC, FMPs, ANSP) who have put forward this cooperation between them. Sharing airspace status was the opportunity to promote the awareness about the diversity of drivers behind each user.

All (14) ATM Functionality requirements of PCP ATM Sub-Functionality 3-1 “Airspace Management and Advanced Flexible Use of Airspace” linked to Solution #31 are covered and achieved maturity “V3 completed”.

Recommendations

The validation activities achieved V3 maturity level, however some gaps have been identified and some recommendations have been made to be undertaken in V4:

- Enhance the automated tools support especially on performance impact assessment times and flight list exchange between NMOC and FOC/WOC.
- Update working methods and trainings taking into account the enhancement of tools automation.
- Finalize RTSA data message content in AIXM 5.1 format.
- Ensure SWIM compliancy of services.
- Newly developed procedures will need to be better integrated into the ATC HMI design to better address ARES change of status detection by human and usability.

It has been showed as well that there is a need to refine the principles for identification of the eligible flights based on AUs’ priorities reflected in relative values to their KPIs (for instance the shortest route is not always the most preferable one for the AU). The solution is in the pipeline for delivery and is due to be deployed across Europe in accordance with the Pilot Common Project.

Dynamic Airspace Configuration

Conclusions

In the context of Trajectory Based Operations, the activities performed by P07.05.04 lead to the following conclusions:

- The concept of Dynamic Airspace Configurations is still in early stage of V2.
- Phased approach of DAC with different levels of dynamicity (progressively increasing) has been introduced to cope with different local ANSPs modus operandi, local working methods and systems support, as well as to fit with local level of operational acceptance.
- Performance driven approach has been reinforced.
- Support by automatic tools to the sector configuration process is clearly seen by FMPs and ATCOs as essential in the future to:
    - optimize the allocation of ATCO resources
    - select the most adequate configuration taking into account various operational needs (planning and execution phases)
- Experts believes that the tool supporting sector design for DAC level 1 or the sector configuration and sector opening scheme definition at each adaptability levels will have a positive or even very positive impact both in ARN as well as in FRA airspaces. However, further requirements have been identified and improvements in the algorithms and evaluation criteria are required to support the definition of workable sequence of sector configurations.
- Experts concluded that it would be no negative impact on the ability to build and maintain Situational Awareness for configurations built in DAC level 1 and Level 2, while it is foreseen more challenges for configurations in DAC level 3 due to important changes of the sector shapes.

- Roles and Responsibilities of two main models have been developed and accepted that need to be further validated: 1) fully decentralised DAC management model, and 2) partially decentralised DAC management model.
- The design and location of DMA type 1 and type 2 according to mission effectiveness criteria, eases the collaborative decision making process for its final allocation, as ATCO workload is not negatively affected when managing diverted flights due to DMA activation.
- DMA activation does not impact in sectors workload, the overload in non DAC scenarios stands for the complexity itself of the traffic nevertheless when the DAC Concept is implemented this airspace complexity remains but the new sectorization allows a better distribution of the traffic demand.

Recommendations

The recommendations issued from the validation activities are:

- The two models of DAC management process developed in SESAR1 need to be further validated in order to assess and compare which one provides more benefits from both local and network perspectives;
- Following these two approaches, there is a need to study and validate new procedures to apply to the Airspace Design phase in a DAC environment with particular attention on the definition of the SBBs and SAMs;
- DAC concept has been validated in a limited geographical Airspace. Additional validation shall take place in larger areas covering sub-regional or regional level.
- Man-in-the-loop validations, especially with detailed ASM and ATC procedures need to become one of the main activities to be undertaken within SESAR2020 framework to firmly confirm and ensure operational acceptance of the concept by all involved actors, especially, by airspace designers, airspace managers and ATCOs. A dedicated focus to DMAs integration should also be given, with other ACCs;
- Further research needs have been identified as a continuation of the validation activity associated to the DAC concept;
- The workload/complexity evaluation function used in DAC algorithms shall be improved;
- There is a strong dependency between the DAC concepts and the affected users and their tools: the ATCO's and the CWP. As P07.05.04 is an ATFCM project and not an ATC project, the ATC part has not been covered. Within SESAR 2020, integration of improved workload/complexity function within the DAC process should be envisaged and impact assessment on the controller workload based on FTS validation exercise should be realised. The outcome of the DAC process shall provide ATC with a workable airspace configuration.
- The actual impact of the DAC methodology on Situational Awareness would depend much on CWP supporting tools and ATCOs new training methods, considered by the experts as potential DAC concept enablers. Further research on ATCOs new working methods and associated support tools to enable DAC concept should be investigated.
- Benefits needs to be further validated including CBA that need to be addressed in SESAR2020 program;
- The DMAs defined for validation activities were adapted to specific training mission needs; considering the positive results regarding the impact in network operations, the analysis of DMA type 1 and type2 shall be extended to other ACCs and to other type of missions.
- Additional validation in SESAR2020 shall be performed to assess the technical feasibility of optimum location of DMA-type 1 and optimisation of airspace configuration composed of sectors and DMA type 1.
- There is a need to progressively start addressing and preparing common integrated exercises and activities, especially with DCB and FRA projects in SESAR2020.

2 References

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