Performance Insight

ATM performance benefit pools for improved civil-military cooperation and coordination

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Measuring European Aviation Performance
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BACKGROUND

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The PRC conducts independent measurement, assessment and review of the performance of the Pan-European Air Navigation Services (ANS) system, including its contribution to the efficiency of Pan-European aviation. The PRC strives to identify future improvements and makes recommendations as appropriate.

The PRC maintains an open and transparent dialogue with relevant parties, including but not limited to States, Air Navigation Service Providers, Airspace Users, Airports, social dialogue partners, civil-military organisations, international and national organisations, etc. The PRC conducts research into the development of performance measurement. This includes, inter alia, investigating how performance could best be described/measured in the long-term, developing and testing proposals for future indicators and metrics and contributing to future improvements in performance.

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NOTICE

The PRC has made every effort to ensure that the information and analysis contained in this document are as accurate and complete as possible. Despite these precautions, should you find any errors or inconsistencies we would be grateful if you could please bring them to the PRU's attention.

The PRU's e-mail address is pru-support@eurocontrol.int.

Introduction and background

Flexible use of airspace (FUA) is the ICAO airspace management concept, developed by EUROCONTROL, according to which 'airspace should not be designated as either purely civil or purely military airspace but should rather be considered as one continuum airspace in which all users' requirements and needs must be accommodated.' The FUA addresses **airspace management** at strategic, pre-tactical and tactical levels, which are separate, but closely interdependent management functions and therefore need to be performed coherently to ensure efficient use of airspace.

States have an obligation to meet national security and operational training requirements, as well as meeting the needs of civil airspace users. To achieve this, it is occasionally necessary to restrict or segregate airspace for the exclusive use of military users. To avoid unnecessary constraints in available capacity and flight efficiency, airspace restrictions should be based on actual use and should be cancelled when not required. The PRC promotes the application of the FUA concept and active civil-military coordination processes to ensure the effective management and use of the airspace by both military and civil stakeholders.

The Performance Review Commission has long been involved in civil-military aspects of performance. In 2015, a questionnaire was sent to all member states with the aim of monitoring national compliance with the European Commission FUA regulation (EC 2150/2005) [1]. In the report titled 'Review of Civil Military Coordination and Cooperation Arrangements' the analysis of this questionnaire revealed systemic issues through the Airspace Management (ASM) levels and the flow of communication both within and across the civil and military sectors [2].

In 2022, to get an understanding of the progress since 2015 the PRC with the support of EUROCONTROL CMC Division issued a new questionnaire, collecting data from some military stakeholders. The revised survey showed little change in FUA practices since the first survey in 2015 [3]. In parallel, the PRC launched an independent study on Dynamic Airspace Management [4]. This study reviewed and analysed the current situation at the system level and suggested how a more dynamic approach to airspace could be taken, improving, for example, the reaction times of civil actors to early deactivation of temporary airspace reservations. Specific gaps and bottlenecks were explored, leading to the identification of several areas for improvement, as well as new metrics which establish a sizable cost and environmental benefit from increasing performance in the coming years.

The timing of this topic is particularly relevant given the foreseen increasing demand for airspace from civil and military users and the simultaneous demands on States in achieving Net Zero under on-going climate change related initiatives.

The situation of ATM in Europe, especially in the eastern and southern regions, resulting from the enhancement of military activities in response to the Russian invasion of Ukraine poses additional challenges to both ASM and civil-military cooperation. A main lesson identified so far is that civil-military cooperation and ASM must increase in dynamicity, especially at pre-tactical level, with improved collaborative decision-making to accommodate short term and ad-hoc military demands for airspace while ensuring efficient traffic flows.

Findings of the PRC survey

The 2015 civil military coordination and cooperation questionnaire was developed in coordination with both civil and military stakeholders [2]. The questionnaire was focused on the flow of information through the ASM levels, with particular interest in the information that is available to the Level 2 actors of airspace management and to the airspace managers involved in the pre-tactical activities of airspace allocation to satisfy the requirements of both civil and military airspace users.

The main findings were that areas for further improvement relate to:

- A lack of impact assessments for restricted or segregated airspaces and the effect they have on general air traffic in terms of available ATC capacity and route options;
- An absence of clear national / regional strategic objectives for both OAT and GAT at ASM level 1;
- A haphazard flow of information throughout the ASM process (availability of the right information to the relevant parties at the right time).

The revised survey in 2022 showed little change in FUA practices since the first survey in 2015. Even though some improvements were apparent, the key issues remained present along with the observation that a considerable number of Member States are still using the most restrictive approach to airspace management, in particular at ASM Level 1 (Strategic) we observe an increase of the publications in AIPs (airspace reservation **booked H24 for 365 days** and released by NOTAM, AUP or UUP) while the (EU) FUA Regulation (2150/2005) Article 3, paragraph (c) states that "**the airspace reservation for exclusive or specific use of categories of users shall be of a temporary nature, applied only during limited periods of time based on actual use and released as soon as the activity having caused its establishment ceases**."

The graph in Figure 1 shows that, over the last 5 years, the publication on AIPs (H24/7 activations) has been on a mostly upward trend, driven by increasing use in Spain. However, other States have been using H24 less over time. It should also be noted that some States do not publish any times for their Airspace Reservations/Restrictions (ARES) and instead refer to activation by NOTAM.

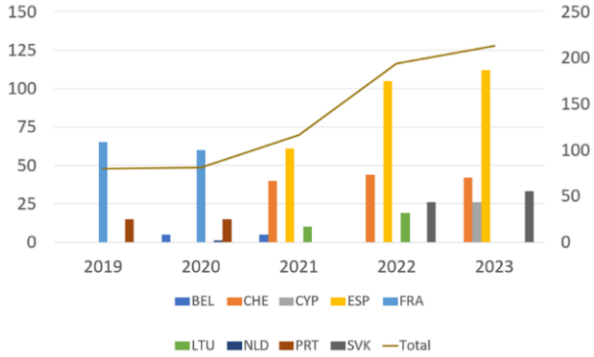

Figure 1 - Number of ARES published as booked H24 for different member states

The concerns with an ARES being notified as H24 in the AIP are that:

- At ASM level1 (Strategic Level), it is generally not available for civil planning.
- Due to the complexity of FUA processes and information to be considered and knowing that member States adopted the FUA concept to their needs. Some airlines prefer to plan their flights based on strategic ASM information available throughout AIRAC cycle publications, mainly relying on what is published in AIP, rather than the daily AUP.

While all member States report that they have successfully implemented the FUA regulation, the findings of the PRU questionnaires show that some individual States apply solutions tailored to their local procedures and systems. Visits to four member states in 2015 have evidenced that within the FUA concept implementation, each state has adapted or established additional national standards and procedures that suit their goals and needs. These modifications may create added difficulties in further evolving the FUA concept to support raising needs for dynamic and enhanced civil-military cooperation, including cross border activities.

To avoid complicated airspace design change processes, some States decided to improve civil-military collaborative planning and decision making at ASM pre-tactical level with priority rules tailored to the specifics of national airspace and procedures, forgetting, or putting aside completely ASM level 1 guidelines and principles.

Examples

The French AMC uses a locally developed priority system to weight the civilian traffic demand against both airspace capacity and military mission effectiveness requirements. The rule allows a priority usage by GAT of a particular area, well established in advance and for specific periods, to enable capacity for traffic peaks management by introducing traffic demand thresholds (flights per hour) above which some restrictions to military activity are applied. Limited in time, these measures must nevertheless still allow achievement of some major military missions.

The Italian AMC books some ARES to the minimum needed for the training mission. The concept allows the military to extend the usage of airspace in the tactical phase when needed to complete a training mission. In this case, the civilian flights are vectored around the airspace reservation in question. This approach should enable more civil flights to be planned through an ARES than when a longer reservation is made.

These above examples reflect differences in execution of the FUA concept, while highlighting the national nature of ASM, which cannot be neglected when addressing harmonization needs. Both states believe that their approaches lead to better outcomes for capacity and flight efficiency / Net Zero. However, there is little evidence at network level to determine the impact of the approaches on the efficiency of traffic flows.

Study on Performance of "Dynamic Airspace Management"

Summary of Findings

The study reviewed and analysed the current situation at the system level and suggested how a more dynamic approach to airspace could be taken, for example, improving the reaction times of civil actors to early deactivation of temporary airspace reservations.

The objectives of the study were to:

- Review current airspace management processes and emerging requirements, identifying bottlenecks in current practices.
- Analyse process implementation, the potential for benefits and recommendations for enhancements.
- Validate airspace management monitoring measures and make recommendations for a transition to dynamic airspace management.
- Consult with key stakeholders (civil and military) on the conceptual approach/requirements, findings, and proposed monitoring measures.

The study considered where gaps and bottlenecks occur in the existing systems and explored possible opportunities to improve. It was found that:

- there remain low levels of record keeping since the first survey in 2015;
- there does not appear to be significant post operations analysis;
- states are not routinely publishing performance indicators.

Several key recommendations were offered to address the inflexibility of airspace use in European member states. In these, the importance of better collaboration and coordination between civil and military stakeholders is emphasized, to develop and share best practices. The study suggests a thorough examination of the airspace update processes, to

be more seamlessly integrated into flight re-planning and operational activities. The practice of tactical directs among pilots and air traffic controllers is encouraged, provided the following actions are timely and within the operational capabilities of the actors concerned.

Lastly it is highlighted how the adoption of the Variable Profile Area concept through the creation of larger but more flexible military areas could result in significant reductions in civil flight fuel consumption and the corresponding emissions while also giving larger effective areas for mission training. It should be noted that an increase of ARES areas will require a proportional upscale in communication and operational response time to take full advantage of the free space for GAT within these areas.

An example of future larger ARES areas is given by the North Sea Project, an initiative that seeks to address the evolving airspace requirements arising from advanced "5th Gen" manned and unmanned aircraft through the establishment of large cross-border/FIR training areas (CBAs) over the high seas or land for shared use among geographically aligned member states. Such initiatives prioritize modularity in airspace design, enabling military airspace users to configure airspace volumes efficiently by selecting and combining elementary 3D modules within a defined geographic perimeter. A modular approach can mitigate impacts on major traffic flows and enhance routing flexibility.

Potential Future Indicators

In this study four analyses were developed with the aim of becoming future monitoring and performance indicators. These potential new indicators are intended to be complementary to existing indicators, with the aim of improving understanding of the impact of the dynamic management of airspace. The potential future indicators are:

- **ARES-MO** (Monitoring indicator) - This concerns the probability that a flight partially circumnavigates a non-active ARES and is a missed opportunity for taking a shorter route through it. This indicator may be integrated into HFE-ARES or needs further work to be a stand-alone indicator. E.g., number of missed opportunity flights per ARES.

- **ARES Occupancy** (Monitoring indicator) - This concerns the number of civil aircraft in an ARES (active or non-active state) at any given time, such as in 15-minute windows. E.g., Total, or average ARES occupancy by civil flights between, e.g., 0900-1700 per State over a year, divided into weekday and weekend flights. This time period corresponds with nominally activated periods but could be made more precise to include actual times for active and non-active ARES. This indicator is already a standard analysis of the PRISMIL database tool.

- **AUP Analysis** (Monitoring indicator) - This analyses the evolution of AUP bookings over the course of one day's operations. This is not the same as airspace usage but does give insight into the level of airspace needed by the military. E.g., Total airspace volume hours per year per State for AUP and UUP at, e.g., 0900. This indicator is also a standard analysis of the PRISMIL database tool.

- **HFE-ARES** (KPI) - This indicator extends the analysis of the missed opportunity flights into (a) an assessment of the probability that a flight's routing really was a missed opportunity for a better route; and (b) the impact in additional flight minutes of the missed opportunity. E.g., Total ARES flight extension per State, in terms of additional flight minutes converted to approximate fuel burn and CO_2. Such data could then be developed to support European, State and airline actions to minimize flight extension. This could cover active and non-active ARES.

Along with these indicators, several other propositions are under study within the existing work groups. The evaluation of these propositions will be carried out by the PRC in 2024.

Quantitative Analysis

ARES Flight Extension

The amount of deviation for a flight flying around an ARES was estimated through the comparison of flight tracks around an ARES with historic tracks through it, e.g. when the ARES was non-active. Figure 2 shows examples of such tracks.

For the flights shown in Figure 2, AUP data for the same date was analysed and there is a high confidence that the airspace was not in use by the military at the time. The flight extensions as a result of routing around the ARES boundaries were between 2.3% and 3%.

Several ARES were studied to quantify the general impact of flight extensions. Taking flights around ARES LFR108HW in Southwest France as an example, outside the period when it is normally reserved (0700:1600), 15 weekday flights were identified, generating horizontal flight extensions between 2% and 4% totalling 59 minutes for the day. Extrapolating these results for a year it amounts to 328 flight hours that might have been avoided, 687 tonners of fuel burned (at a nominal 35L per minute), and 1735 tonnes of CO_2 produced (assuming CO_2 = 3.15 x fuel (kg) and 1L fuel ~ 0.8Kg).

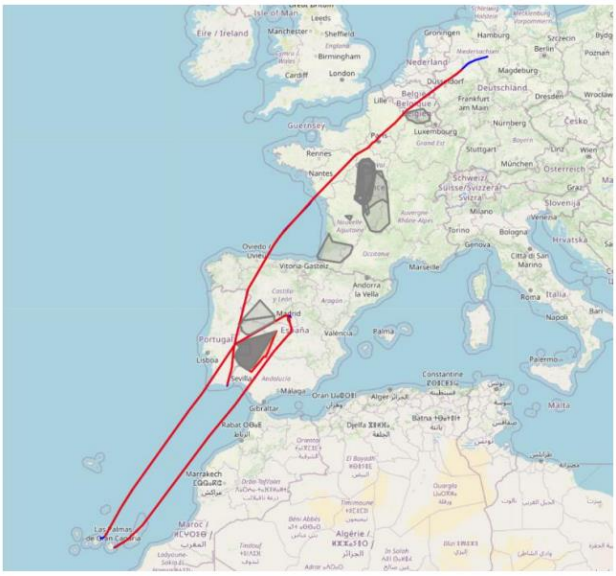

Figure 2 - Example of flight tracks around ARES LER86B.

ARES Booking and Flights Through the ARES

An analysis of PRISMIL data, combining various Network Manager sources such as LARA, the Flight Tactical Flow Model (FTFM), and State AIPs, allowed a comparison between the times that an ARES is booked for and the flights that planned and/or went through the ARES.

As an example, for a given ARES, between 0800 and 0900 on weekdays totalled over 23 weeks, the data showed that, approximately:

- 8,000 minutes booked for the ARES through AUP and UUP;
- 7,000 minutes that the ARES was actually activated;
- 500 flights planned through the ARES;
- 2,000 flights that passed through the ARES.

One interpretation for the difference between the planned and actual flights passing through the ARES is that this is caused by tactical directs coordinated between military and civil controllers, some of which may also be at the request of flight crew. An uncertainty remains as to whether an active airspace is temporarily deactivated without notifying or an active airspace is crossed by civil flights.

When comparing the number of flights planned to go through an ARES and the number of actual flights that went through the ARES on weekends, it was observed that, while there are no registered bookings at the weekend there remains a difference between the number of planned flights and actual flights through the ARES.

This raises the following questions:

- Because ARES are generally not booked at the weekends, why are there not more civil flights using them?
- Why is there still a difference between CPF and FTFM counts at the weekends?

Previous analyses have suggested that some flights are not being planning according to the AUP, which is published on D-1. Here, if an ARES is booked H24 on a State's AIP and then notified as non-active via AUP/UUP, flights that aren't planned according to the AUP/UUP will not be able to take advantage of this information.

Lessons learned and proposed improvements

Big Military Exercises and Sports Events

In August 2012 the **FABEC Olympics Cell** was set up to manage the increased air traffic demand due to the London Olympic and Paralympic Games. The increased coordination between civil and military stakeholders enabled the fine tuning of military activities in line with the increased demands of civil air traffic. New flight profiles, coordination procedures and off-load scenarios were established and new routes were made available to airspace users. As a result of this increased collaboration, notable performance improvements were achieved, with a significant decrease in the average ATFM *en-route* delay per flight. However, there was a reported increase in the horizontal *en-route* extension in comparison with flight plans, which may not be tolerable in the context of Net Zero.

In June 2023, Germany hosted **Air Defender**, NATO's largest military deployment exercise, spanning 9 days and involving around 250 military aircraft from 25 nations across three exercise areas. The successful execution of this massive exercise was the result of close collaboration that began in 2022, when EUROCONTROL, in partnership with the German Air Force, NATO, airlines, the German Air Navigation Services Provider DFS, and other ANSPs, stated the development of airspace impact assessments. This collaborative effort ensured that the exercise had a relatively low impact on civilian air traffic, accounting for only 18% of the total network delay. This achievement highlights the significance of robust civil-military cooperation for effectively accommodating military exercises without disrupting regular aviation operations, especially as air traffic approaches pre-pandemic levels.

The results demonstrated by the 2012 FABEC Olympics and the Air defender exercise show that through increased civil-military cooperation and timely planning it is possible to construct solutions that accommodate pressing military needs while keeping the disruption of GAT operations to a minimum. However, as noted above, future exercises may need to be more conscious of environmental impact with potential trades in delay and flight efficiency.

Knowing that military exercises are expected to increase due to the ongoing war in Ukraine and sports events will continue to happen recurrently, there is an incentive to consider the development of more permanent FUA solutions, with well-defined strategies for predictable spikes in General Air Traffic (GAT) demand. Rather than creating dedicated cells ad-hoc, enduring FUA mechanisms should be established to seamlessly adapt to varying demand scenarios. It should also be assessed why such solutions haven't yet been employed and if there are any limitations, such as a lack of resources, impeding these decisions.

New ATM situation in Europe generated by the Ukrainian war

The invasion of Ukraine and the resulting increased activities of NATO on the Eastern Flank of the Alliance have challenged existing civil-military coordination procedures. Requirements for airspace availability, cross-border operations, flexible flight planning and execution have shifted.

During the start of the operation, it has led to significant additional workload both for civil and military actors to address military requirements, while safeguarding civil operations. In the meantime, the involved states and NATO have found different solutions and "workarounds" to address these challenges.

Findings

- Current design and daily management procedures of airspace reservations do not always fit mission requirements regarding geographical position, lateral dimensions, and/or vertical dimensions.
- Required airspace used for reservations or restrictions might extend beyond the borders of one country. Often the platform, or protocol for bi/multilateral civil-military

coordination on FUA level1 (i.e., for airspace design) is missing.

- The military planning process is not synchronized with the FUA process. The military plans are often finalized after the Airspace Use Plan (AUP) is already published. This leads to frequent changes via UUP, including also new requests.
- National airspace management procedures can differ significantly between the countries due to different national constraints, legal frameworks and local specificities.
- There are harmonized procedures in place to support delineation and management of ad-hoc airspace reservations, they need to be better communicated and used.
- The Network Manager is not always aware of the actual airspace status, hence an effective network level impact assessment capability is missing.
- Dynamicity of airspace management and enhanced civil-military coordination are key military requirements to ensure tailored to requirement and effective missions.

Civil Use of Released Airspace (CURA)

Since the outset of the FUA Concept, the European Military have been striving to find solutions to alleviate the impact of airspace reservations/restrictions (RSA) on route planning and usage, while safeguarding the effectiveness of their essential security and defence task. The importance of that contribution is recognized by the integration of performance metrics for CURA – or Civil Use of Released and Available Airspace.

In the pursuit of optimizing the civil use of released airspace (CURA), several critical considerations and lessons have emerged to guide future improvements. While the early release early deactivation of an Airspace Reservation/Restriction (ARES) offers opportunities for tactical route adjustments, it is imperative to establish streamlined processes that enable airlines and air traffic managers to promptly incorporate these changes into a flight. This involves fostering effective communication channels between stakeholders and optimizing decision-making mechanisms.

Understanding the operational procedures of airlines is fundamental for CURA optimization. This topic should be the object of future studies given that with the currently available information no conclusions can be drawn with sufficient precision. It should be assessed how airlines manage day-to-day operations and how dynamic their processes are given the impact they represent.

One other challenge faced in CURA is the changing availability of special use airspace. Early deactivation of a booked ARES may benefit airlines from direct improvements in flight efficiency. However, this is hard to achieve at the pre-tactical level, as Network Manager processes require a 3-hour notice for re-submitted flight plans.

Further information on CURA can be found in the document produced by the EUROCONTROL CMC Division via the following link: https://www.eurocontrol.int/publication/aircraft-operator-uptake-available-and-released-airspace-reservations-cura-barriers

Enhancing Airspace Management

In the pursuit of optimizing airspace management, several key points require immediate attention. Each of these points, with its unique significance, can contribute to a more efficient and coordinated airspace management system.

- **Standardization of procedures** - Despite individual states tailoring solutions to their specific needs, the FUA regulation designates responsibility to ANSPs for complete implementation. Standardization would uphold mandates and ensure consistency in the implementation of FUA across Member States.
- **Information flow** - Effective airspace management hinges on the smooth and uninterrupted flow of information. It is imperative that airspace stakeholders

prioritize the establishment of robust communication channels. Ensuring that vital information reaches all relevant parties in a timely manner is essential to prevent disruptions, delays, and miscommunication.

- **Enhancing ASM Level 1** - A critical aspect of airspace management is the improvement of Airspace Management (ASM) Level 1. To achieve this, it is vital to have a comprehensive understanding of how airlines operate and make real-time decisions. By aligning airspace management strategies with the operational procedures of airlines, we can optimize route planning, enhance airspace utilization, and minimize delays, ultimately benefiting all parties involved. It is worth highlighting the efficacy of local airspace management at Levels 2 and 3, demonstrating effective coordination between civil and military counterparts.
- **Implementation of Long-Lasting Solutions -** Build upon success cases in airspace management to develop more permanent and versatile solutions that can be applied in various scenarios, including major events.
- **Performance Metrics -** Develop and adopt new monitoring and performance indicators, enhancing record-keeping throughout the entire Airspace Management (ASM) process. This will help in the development of impact assessments and provide a foundation for evidence-based decision-making.
- **Activation and Deactivation publications AIP (ASM – Level 1)** - The activation and deactivation of military areas plays a crucial role in airspace management, with significant implications for both civil and military operations. The reliance on notifications through digitalized sources such as Airspace Use Plans (AUP) and Updated Use Plans (UUP) is paramount. This information, coupled with timely NOTAMs, must be communicated without exception. Only with comprehensive data and feedback from these sources can we make meaningful improvements in ASM Level 1 planning.
- **Digitalization of NOTAM** - The digitalization of Notices to Airmen (NOTAM) stands as a milestone in modernizing airspace management. This transition has the potential to streamline the communication of critical information, reduce the margin for errors, and enhance the overall effectiveness of the system. The implementation of digital NOTAMs offers a more seamless approach to disseminating essential data, reducing delays, and improving operational efficiency.

Conclusions

The analysis of previous questionnaires and studies reveals a need for continued improvement in the implementation of the Flexible Use of Airspace (FUA) concept among member states. While local airspace management at levels 2 and 3 demonstrates effective communication and collaboration between civil and military counterparts, challenges persist at the network level. The availability of crucial information and the efficient utilization of released airspace remain areas of concern.

Key actions (messages) are proposed to further facilitate the implementation of the FUA concept, resulting in more efficient airspace management systems. Among these, the digitalization of notification procedures, such as NOTAM, coupled with the standardization of informational software such as LARA and PRISMIL, holds the potential to substantially enhance the flow of vital information. This, in turn, would ensure that the right information reaches the right individuals promptly. Furthermore, it would facilitate a strengthened feedback loop between ASM levels 3 and 1, enabling the refinement of future strategic objectives for both OAT and GAT.

The journey toward optimized airspace management can be grounded in pragmatic steps to overcome existing challenges. The path forward rests on the commitment to bridging information gaps and maintaining collaboration among all stakeholders to help in building permanent and adaptable solutions.

Should you wish to comment on this publication, or to contact the PRC, please email us @: pru-support@eurocontrol.int.

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