

# AIRSPACE MANAGEMENT PROCEDURES IN EUROPE

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## ABSTRACT

Airspace is resource with limited capacity, and the way it was organised wasn't sustainable. Airspace division and route structure evolved from fixed navigational aids and CNS<sup>1</sup> systems. Enhancements made in aircraft and CNS systems enabled aircraft to be less dependent to fix navigational aids and routes, and increased the flexibility allowing aircraft to fly almost directly from point to point.

It is in interest of all airspace users to maximise the usage of airspace as it represents scarce resource. The ATM<sup>2</sup> 2000+ Strategy states that "the objective is to provide sufficient capacity to accommodate the demand of all users in an effective and efficient manner at all times, and during typical busy hour periods, without imposing significant operational, economic or environmental penalties under normal circumstances"[1],[2]. The ATM Strategy 2000+ is no longer in force and is replaced by a number of specific Strategic Documents (Airspace Strategy, Air Traffic Flow Capacity Management Strategy, etc.) that are the part of Strategic Guidance in Support of the Execution of the European Master Plan [3].

This paper elaborates the current process within the Flexible Use of Airspace Concept and in the conclusion it provides the future view and direction that Advanced Flexible Use of Airspace Concept would take on.

**Keywords:** airspace, flexible use of airspace, airspace segregation, transport demand

## 1 INTRODUCTION

In the eighties the need for airspace enhancements was born as there was continuous rise in the air transport in Europe. In the beginning of 90s the European Civil Aviation Conference (ECAC) accepted the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) aiming at the increase of European air traffic capacity [4].

In the 1992 the EATCHIP<sup>3</sup> Task Force on Airspace Structure and Management established the first set of principles for the three levels of the Airspace Management. According to the EATCHIP Report the Flexible Use of Airspace (FUA) Concept provides Air

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<sup>1</sup> CNS – Communication Navigation and Surveillance

<sup>2</sup> ATM – Air Traffic Management

<sup>3</sup> EATCHIP – European Air Traffic Control Harmonisation and Integration Programme

Traffic Control with a potential to increase airspace capacity [5]. It reduces the need for segregation of activities since adequate operational (military)/general (civil) traffic (OAT/GAT<sup>4</sup>) separation is mainly achieved by enhanced real-time civil/military system that will ensure segregation of airspace based on real-time usage within a specific period of time. The Eurocontrol Report emphasised that the Usage of FUA<sup>5</sup> Concept would lead to:

- An increase in ATC capacity and a reduction in GAT delays;
- More efficient ways to separate OAT/GAT;
- Enhanced real-time civil/military co-ordination and a reduction in airspace segregation needs;
- The definition and use of temporary segregated areas being brought more closely in line with military operational requirements.

In order to enhance the FUA Concept, the European Commission laid down the common rules for the flexible use of airspace application (EC<sup>6</sup> Regulation No 2150/2005) [6]. Regulation defines the technical and operational requirements for civil military coordination regarding the use of airspace. As the Interoperability Regulation defines essential requirements for the support of the implementation of civil/military coordination, the European Commission/Eurocontrol Flexible Use of Airspace Community Specification provides details of procedures and requirements for the implementation and specification of FUA Concept. The adaptation of the SES<sup>7</sup> Regulations and the FUA rules reinforced the legal status of Flexible Use of Airspace

The FUA Concept is important part of the Dynamic Management of European Airspace Network (DMEAN) Programme [7]. The Dynamic Management of European Airspace Network is a short-term initiative which aims at delivering additional capacity, improve flight efficiency, release latent ATM capacity and introduce new concept for operational planning and management of the European ATM Network. The FUA Concept is one of the key points in the next generation ATM defined and developed under the Single European Sky Research Programme (SESAR).

## **2 FLEXIBLE USE OF AIRSPACE CONCEPT**

The baseline of the FUA Concept is that airspace should no longer be designated as either military or civil airspace, but should be considered as one continuum. The usage of airspace should be based on a day to day basis, where consequently any airspace segregation should be of a temporary nature. The application of the FUA Concept ensures that, through the daily allocation of flexible airspace structures any segregation of airspace is based on real usage within specific time period. The FUA Concept addresses the following areas:

- Safe use of shared airspace;
- Availability of airspace to civil operations during weekdays;
- Non availability of airspace to civil operations during weekdays;
- Penetrability of shared airspace (mixed operations); and ,
- Availability of airspace to civil operations during weekends.

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<sup>4</sup> OAT/GAT – Operational Air Traffic/General Air Traffic

<sup>5</sup> FUA – Flexible Use of Airspace

<sup>6</sup> EC – European Commission

<sup>7</sup> SES – Single European Sky

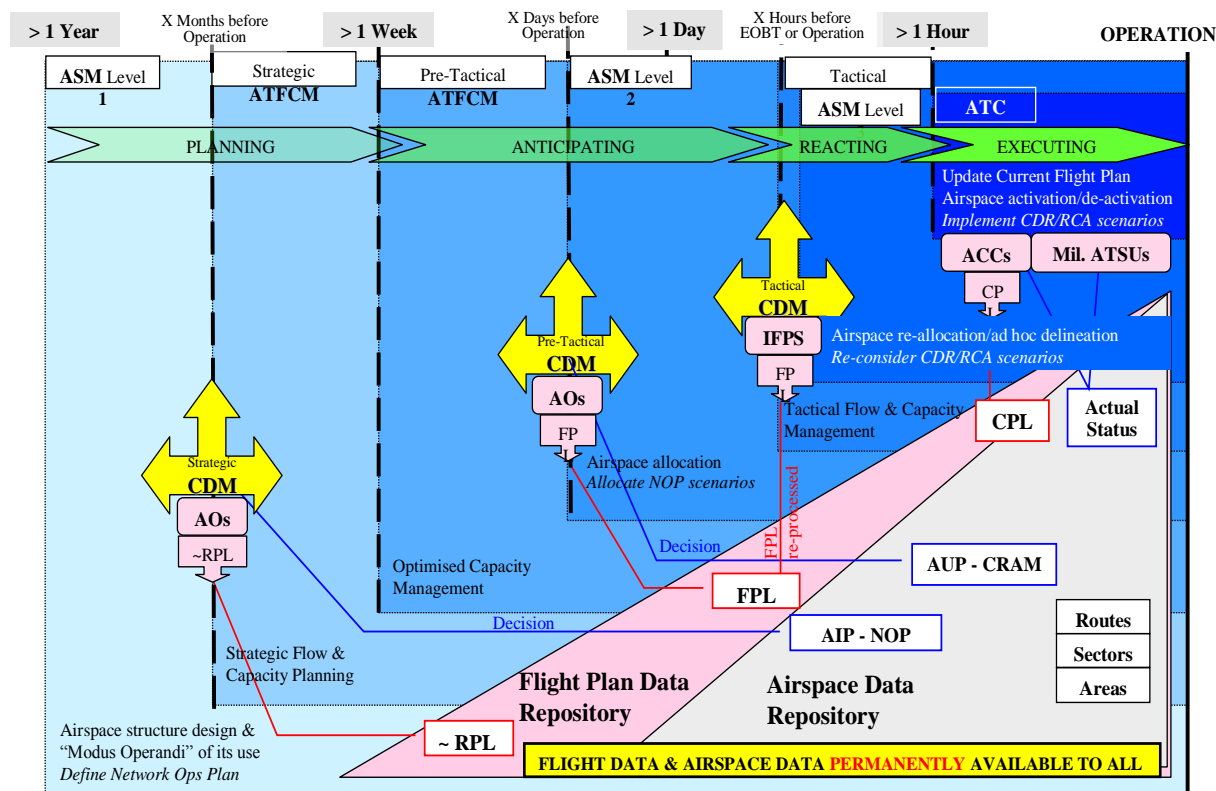


Figure 1: ASM/ATFCM/ATC Concept of operation

The FUA Concept is divided to three interrelated levels of Airspace Management (Figure 1):

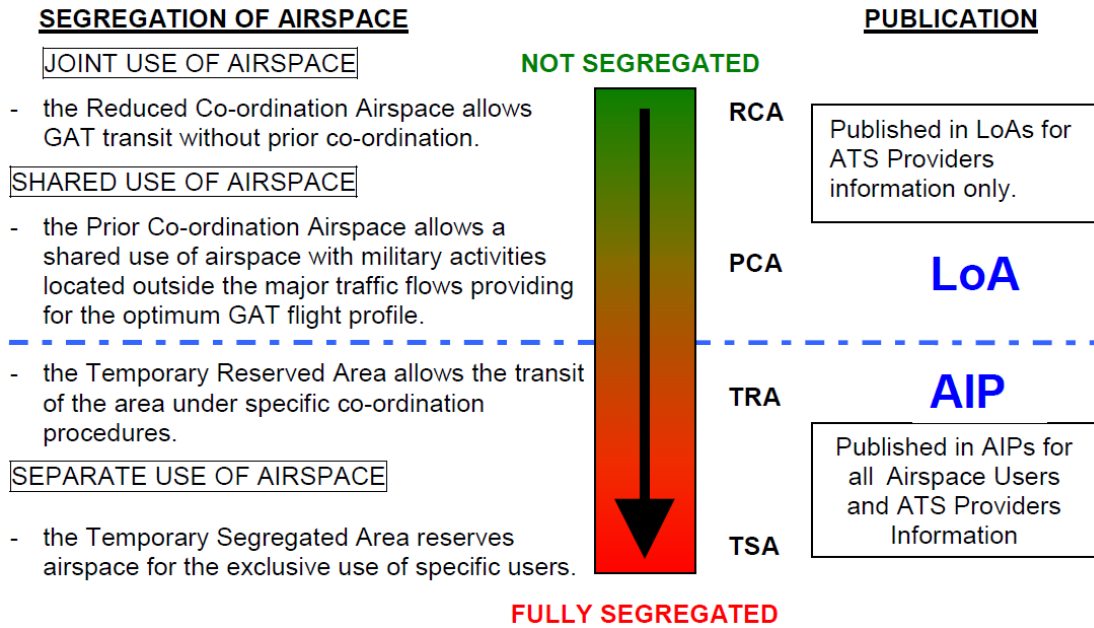
*Strategic Airspace Management (ASM Level 1)* is a joint civil military process within national High Level Airspace Policy Body (HLAPB) that formulates national ASM policy and carries strategic planning work. It encompasses of airspace structures design (training areas, routes and ATC sectors) and the definition of suitable options how they could be used together (modus operandi).

*Pre-tactical Airspace Management (ASM Level 2)* consists of a day to day management and temporary allocation of airspace through Airspace Management Cell (AMC) in coordination with Central Flow Management Unit. It also includes the selection of a modus operandi between the options explicitly or implicitly defined at Level 1.

*Tactical Airspace Management (ASM Level 3)* consists of the real time activation, deactivation or reallocation of airspace allocated on ASM Level 2, and resolution of specific airspace problems. It also consists of deploying and operating the selected option in real-time [8].

### 3 STRUCTURES AND PROCEDURES OF THE FLEXIBLE USE OF AIRSPACE

The FUA Concept uses airspace structures that are mainly suited for temporary allocation and/or utilisation (Figure 2). There are the following different airspace structures; Conditional Routes (CDRs), Temporary Segregated Areas, (TSAs), Temporary Reserved Areas (TRAs), Cross-Border Areas (CBAs) or those Danger or Restricted Areas (D, R) subject to pre-tactical or tactical allocation under the Temporary Airspace Allocation (TAA) process, as well as Reduced Coordination Airspace (RCA) or Prior Co-ordination Airspace (PCA) procedures used for flexible airspace management.

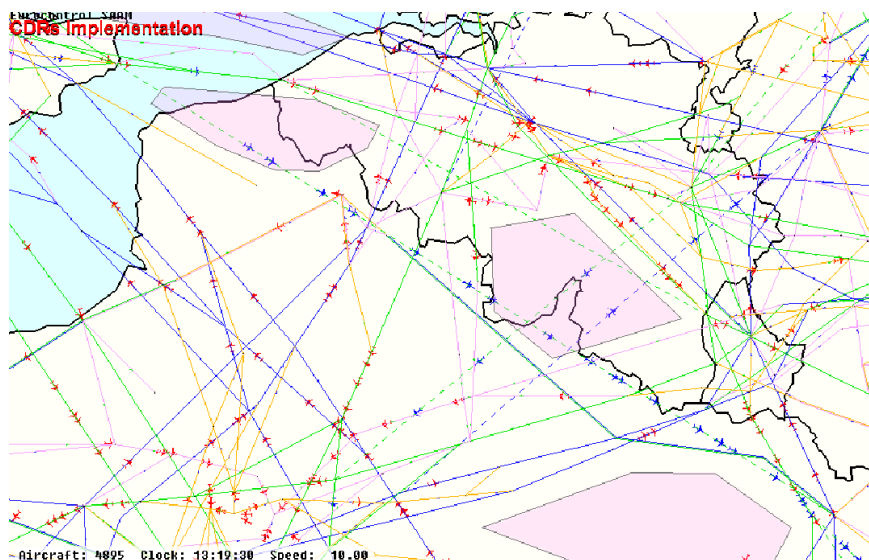


**Figure 2: Segregation of airspace**

According to Eurocontrol an airspace segregation scale can be defined from the joint/shared use of airspace to the temporary reservation/segregation of airspace.

### 3.1 FUA route network

The fundamental component of the European ATM system is the route network. In order to produce safe ATC capacity there is a need for systematisation of traffic flows which are passing through ATC sector, through a route network and through a number of rules that govern the utilization of routes. There is a distinction between permanent routes in controlled airspace, which are available unconditionally and Conditional routes (CDR), which are ranked according to the level of availability for ATC usage of flight planning (Figure 3).



**Figure 3: Conditional Route Activation**

Conditional routes are mainly used for managing training/shared areas, and can also be used for regulating civil traffic flow, but there are a very small number of these cases. A Conditional route is an ATS route or a portion of route which can be planned and/or used

under specific conditions only. In the following text the CDR abbreviation will be used for Conditional routes.

CDRs allow the definition of more direct and alternative routes that are complemented and linked to existing route network (Table 1). CDRs can be established at ASM<sup>8</sup> Level 1:

- Through areas of potential temporary segregation (e.g. TRA<sup>9</sup>, TSA<sup>10</sup>), with opening/closure conditions resulting from associated military activities, and
- To address specific ATC conditions (e.g. traffic restrictions or ATC<sup>11</sup> sectorisation compatibility) with opening/closure conditions resulting from purely civil activities.

**Table 1: Conditional Routes Categories**

CDR code	Availability for flight planning and ATC purposes	Availiability to ATC only (e.g. airborne rerouting)	Rerouting Option
CDR 1	Always available during published times (H24 or fixed period on fixed FL) in the national AIP, unless closed during pre-tactical phase.	Available when closed for flight planning – subject to civil/military coordination.	Yes
CDR2	The route is available for flight planning during CDR 2 periods published in the Conditional Route Availability Message (CRAM) issued by CFMU one day in advance. NOT available for planning unless opened during pre-tactical phase.		No
CDR3	Never available for flight planning. In specific conditions Air Traffic Control Officer (ATCO) may offer short notice routing using CDR 3. Used on ATCO instructions only.		No

Even when CDR<sup>12</sup> 1 routes are available for flight planning, a flight may be subject to airborne rerouting when there is military activity in associated area. Result will be a slight a change of vertical or horizontal flight profile (rerouting) [9]. An alternative route to fly around shared airspace is published, and thus the fuel loading for civil aircraft is based on the assumption that the alternative route is flown. CDR 2 cannot be closed once made available for flight planning since CDR 2 does not foresee alternative rerouting when the shared area is used by military. In this situation fuel load is based on the assumption that there will be no alternative rerouting. CDR 3 may be used by ATC for rerouting as its result is shorter route than planned.

### 3.2 Shared airspace in europe

Shared airspace areas are complex system of airspace volumes which are adaptable to meet various military training needs (Figure 4). A military area can be partitioned in many sub-volumes (modules) to meet different military training mission profiles.

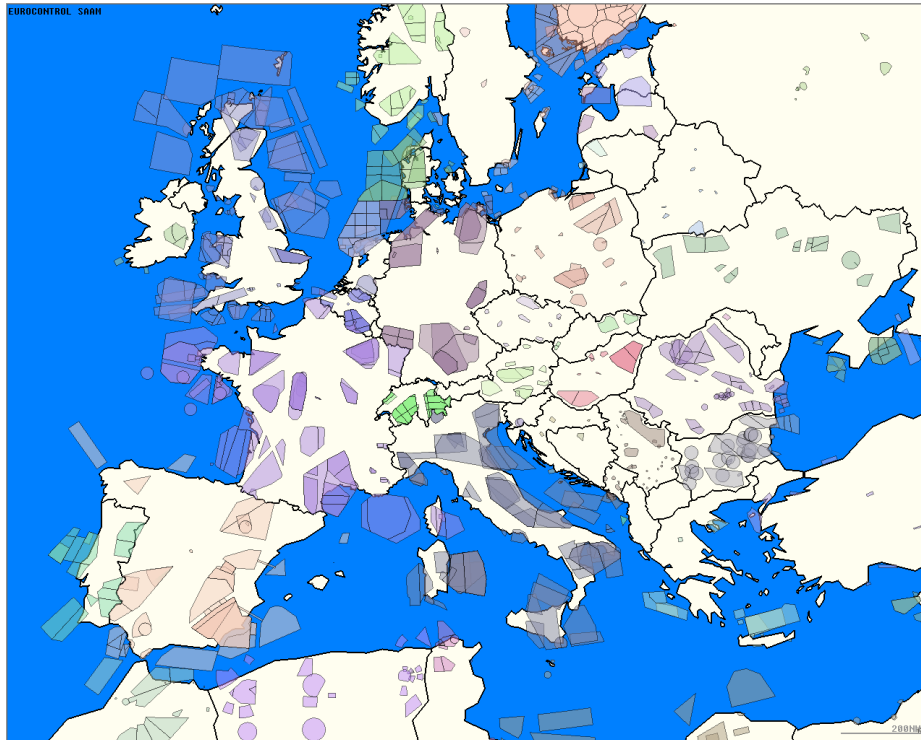
<sup>8</sup> ASM – Airspace Management

<sup>9</sup> TRA – Temporary Reserved Area

<sup>10</sup> TSA – Temporary Segregated Area

<sup>11</sup> ATC – Air Traffic Control

<sup>12</sup> CDR – Conditional Routes



**Figure 4: Shared areas**

Shared areas can be classified according to the degree of sharing (manageability) which is foreseen between civil and military activities. Shared areas are grouped into three main categories according to their manageability:

- *Airspace Management Cell (AMC) Manageable Area*: Shared areas which are available for pre-tactical management on a daily basis. Their availability to civil traffic shall be known at least some hours in advance and, when assigned to civil traffic, they cannot be revoked without previous consultation with the ATC units. Consequently the preparation of routes and ATC sectors in the pre-tactical ASM (Level 2) can benefit from the availability of this airspace.
- *Non AMC manageable area*: Areas subject to tactical management for which real time activity is well known via NOTAM<sup>13</sup> published and through coordination between the appropriate military/civil control units. These areas are assigned and revoked to civil traffic in real-time operations without previous advice. Consequently the preparation of routes and ATC sectors planning in the pre-tactical ASM does not benefit of the availability of this airspace.
- *Areas not manageable at all or permanently prohibited (P)*: for which no information on their actual military activity can be retrieved. Consequently this airspace cannot be used by civil traffic during the published hours of the activation of non-manageable areas.

Different names of shared areas and the level of ATM manageability depend on the type of activity exercised in the area (Table 2). The code can only be identified by reading the area characteristics which are published in the Aeronautical Information Publication (AIP) of the States concerned.

<sup>13</sup> NOTAM – Notice to Airmen

**Table 2: Categories of shared airspace**

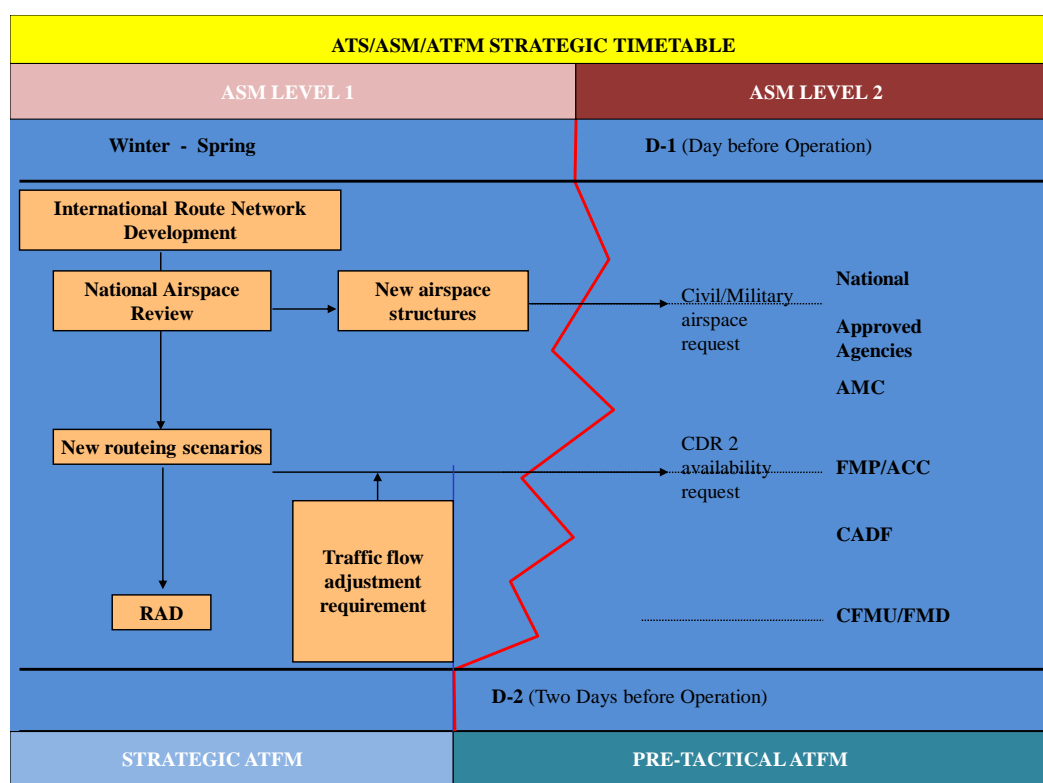
<b>Code of shared area</b>	<b>Definition</b>	<b>Potential classes of manageability</b>
Temporary Reserved Area (TRA)	Defined volume of airspace <b>temporarily reserved</b> , for the specific use, but through which civil and other traffic may be allowed to transit, under ATC clearance.	AMC Manageable
Temporary Segregated Area (TSA)	Defined volume of airspace <b>temporarily segregated</b> for specific activities, through which civil and other traffic will not be allowed to transit.	AMC Manageable
Cross Border Area (CBA)	TSA or TRA established over international boundaries.	AMC Manageable
Danger Area (D)	Is an airspace of defined dimensions within which activities <b>dangerous</b> to the flight of aircraft may exist at specified times.	AMC Manageable Non-AMC Manageable Non-Manageable
Restricted Area (R)	Is airspace of defined dimensions, above the land area or territorial waters of a State, within which the flight of aircraft is <b>restricted</b> in accordance with specific conditions.	AMC Manageable Non-AMC Manageable Non-manageable
Prohibited Area (P)	Is airspace of defined dimensions, above the land area or territorial waters of a State, within which the flight of aircraft is <b>prohibited</b> .	Non-manageable

Within the FUA Concept there are two airspace structures that are associated with coordination procedures between civil and military air traffic controllers. Prior Coordination Airspace (PCA) is a portion of airspace of defined dimensions within which individual GAT is permitted to fly off route only after prior coordination initiated by controllers of GAT flights with controllers of OAT flights. Reduced Coordination Airspace (RCA) is a portion of airspace of defined dimensions within which individual GAT is permitted to fly off route without requiring controllers of GAT flights to initiate coordination with controller of OAT flights.

## **4 AIRSPACE MANAGEMENT LEVELS**

### **4.1 ASM strategic level**

Strategic airspace management refers to joint civil military process established by National High Level Airspace Policy Body (HLAPB). In the following chapters the abbreviation HLAPB will be used instead of National High Level Airspace Policy Body. According to European Commission/Eurocontrol Specification for the Application of the Flexible Use of Airspace a HLAPB should be established as a joint civil military body. HLAPB is responsible for formulating national policy and framework for airspace management. The minimum functions that HLAPB should perform in order to establish joint civil military processes are described in FUA Specifications.



**Figure 5: Strategic Airspace Management**

The main function of HLAPB is to ensure a safe and efficient use of the national airspace structures and ATS<sup>14</sup> routes. Based on harmonised agreements derived from collaborative planning with neighbouring states, HLAPB should provide transparency of operational handling at national borders. This is achievable through enforcements of national policies for an effective application and review process, taking into account all stakeholders.

Strategic Airspace Management encompasses activities from collection of airspace requirements to the publication of airspace design (Figure 5).

## 4.2 ASM pre-tactical level

Pre-tactical Airspace Management (ASM Level 2) prepares the resources that will be deployed during the day of operations. Pre-tactical operations start few days in advance given the complexity of airline, ATC and military operations (Figure 6). Some flexibility is necessary on the day of the operations in order to deal with unplanned events.

The ASM Level 2 operations are generally under the responsibility of the Airspace Management Cell (AMC). Airspace Management Cell is according to the Eurocontrol ASM Handbook a joint civil/military cell responsible for the day-to-day management and temporary allocation of national or sub-regional airspace under the jurisdiction of one or more ECAC state(s). Pre-tactical operations are relevant for shared airspace areas classified as AMC Manageable Area, as they are the ones where the opening and closing time period is planned and communicated in advance. Majority of shared areas above FL 200 in Europe are classified as AMC Manageable.

There is standardised approach to conduct ASM Level 2 activities, at state level in Europe. States have decision on:

- Whether to conduct pre-tactical ASM or not;
- How to organise the pre-tactical level of ASM; and,

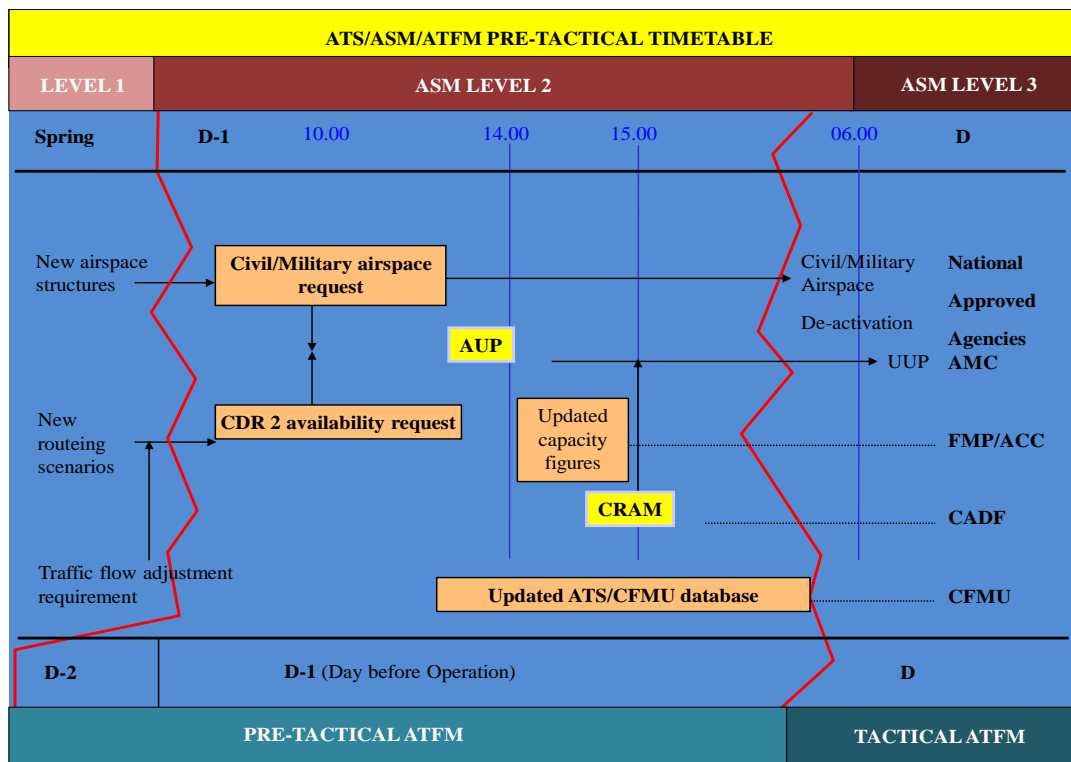
<sup>14</sup> ATS – Air Traffic Services



- How to integrate pre-tactical ATFCM<sup>15</sup> and ASM levels.

According to priority rules and negotiation procedures defined at ASM Level 1, Pre-tactical ASM selects the option of configuring routes, ATC sectors and shared areas in consistent way. The number of suitable options developed within Strategic Level influences the benefits of Pre-tactical phase.

Pre-tactical Air Traffic Flow and Capacity Management (ATFCM Level 2) process involves the preparation of ATC sector configuration in order to accommodate civil traffic demand with a minimum level of penalties (delay and flight efficiency). There is also scenario management and measures as re-routing of flights and/or flows, flight level capping, etc. used in ASM Level 2. If there is still excessive demand on available ATC capacity after all solutions for capacity resolution have been considered, then ATFCM regulations are issued. Main actors in the Pre-tactical ATFCM are Flow Management Positions (FMP) at the ACC and Central Flow Management Unit (CFMU). Pre-tactical ASM and ATFCM are coordinated on State level, whereas Pre-tactical ASM is carried out on State level and Pre-tactical ATFCM is carried out on European level by CFMU.



**Figure 6: Pre-tactical Airspace Management**

States authorise Authorities and FMPs/ACC, to make the requests for airspace allocations to the AMC, and participate in negotiations and co-ordination process initiated by the AMC and to utilise allocated CDRs, TRAs/TsAs, CBAs and other allocated airspaces. Whenever possible the AMC and FMP functions should be integrated. Requests for CDRs are in general based on capacity needs identified by the FMPs/ACCs<sup>16</sup> and in coordination with the CFMU in the pre-tactical ATFCM phase. The FMPs/ACCs submits a request for the activation of CDRs2 to the AMCs concerned CDR2 taking into account the pre-tactical ATFCM co-ordination process and all relevant ATC factors such as sector capacity, equipment

<sup>15</sup> ATFCM – Air Traffic Flow and Capacity Management

<sup>16</sup> FMP/ACC – Flow Management/Position Area Control Centre

status, operational constraints and staff availability. Requests are presented together with traffic forecasts showing the expected capacity shortfall.

After the AMC promulgated the AUP<sup>17</sup> (finished the Airspace Allocation Process), modification of the airspace allocation might be necessary. Modifications of the airspace allocation are affected by the AMC through an Updated AUP (UUP<sup>18</sup>) and consist of any cancellations, changes or new requests. The CFMU collects, consolidates the AUP and UUP, and disseminates the CDR information provided by AMCs. The CFMU (CDAF) extracts from AUP/UUPs the list of available CDRs for incorporation into a single coherent CDR Availability Message (CRAM) and eAMI. The eAIM (Air Traffic Flow and Capacity Management Information Message) informs the Aviation community whenever they consider it relevant [11].

The following data is available during ASM Level 2 phase one day before operations for the selection of the most suitable option for ASM Level 3 (Table 3).

**Table 3: Available data supporting pre-tactical decision making 1-day before OPS**

Type of data	Description
Civil traffic data	Usually the past flights data contained in CFMU archive are used.
ATC sector configurations and ATC sector capacity value	Historical and current data available in CFMU and national archives.
Historical ATFM regulations	Contained in CFMU archive and in national logs
Military mission data	They are presented to AMC by military approved agencies in charge for scheduling military operations. It contains essential data for ASM such as planned take off time, type of mission, number of aircraft, requested FL band, requested area or amount of airspace volume, etc.
Military training areas	Volumes and/or sub-volumes of shared airspace as described in AIS publications in the current AIRAC cycle
CDR routes and other route restrictions (e.g. RAD).	As described in AIS publications in the current AIRAC cycle

Pre-tactical processes today are relatively standard across Europe one day before the operation. They consist of three activities in sequence:

- In the first step, military and civil needs are evaluated in order to decide the ATC sector configuration and the assessment of training areas to military activities. At this stage there is evaluation of the available options between AMC (ASM pre-tactical unit) and FMP (ATFCM pre-tactical unit). The detail sector configuration is agreed at ACC/FMP level.
- In the second phase the possibility to release CDR routes for flight planning is validated against the assignment of shared areas to military activities and the ATC sector configurations which are planned to be deployed on day of operations,
- In the last, third step, the status of shared areas and CDR routes are disseminated to ATC and military controlling units through Airspace Use Plan (AUP) message. CDRs available for flight planning are disseminated to the CFMU in a reduced AUP format, and then CFMU CDAF (Centralised Data Airspace Function) disseminates the information to all airspace users through CRAM (Conditional Route Availability Message). At the same time the FMP communicates ATC sector configurations and sector capacity values with the CFMU.

<sup>17</sup> AUP – Airspace Use Plan

<sup>18</sup> UUP – Updated Airspace Use Plan

When the options are selected for the day of operation, there is a need for sharing the relevant information to all parties. All information's needed to be updated continuously (Table 4).

**Table 4: Data dissemination in ASM pre-tactical operations**

Dissemination of the status of pre-tactical operations between 1 day and few hours before OPS					
Type of data	Type of message	ATC and military units in the shared airspace.	Other military and ATC units inside the State.	Cross border units	CFMU
ATC sector configuration and ATC sector capacity values.	State format	Yes	Yes if necessary	No	Yes
CDR route availability for flight planning	AUP	Yes	Yes	No	Yes
	UUP	No	No		No
Shared airspace opening/closure	AUP	Yes	No	No	Yes
	UUP				No
CDR route availability for ATC only	State format	Yes	Yes	No	No

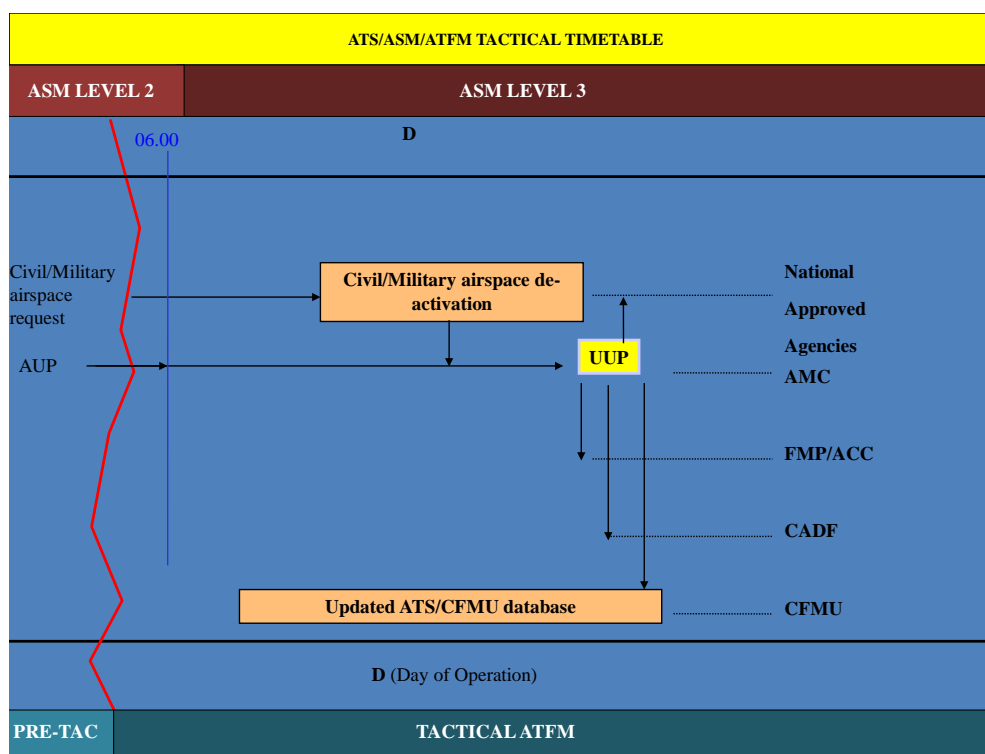
Even though on the day before operations the CFMU has good visibility of applied ATC sectors configurations and route availability (Route Availability Document, NOP portal), there is no visibility of activation/deactivation times of shared airspace at European Level.

### 4.3 ASM tactical level

Tactical Airspace Management generally consists of real time coordination between civil and military air traffic controller (Figure 7). The main activities of ASM Level 3 phase are: real time activation and deactivation, reallocation of airspace allocated at ASM Level 2 and the resolution of specific airspace problems and/or traffic situations between civil/military ATS units. The Eurocontrol ASM Handbook covers common aspects applicable at ASM Level 3, leaving the State the possibility to define specific procedures for real time coordination between civil and military unit.

Real time operations mainly deal with two types of situation;

- Organisation of an almost simultaneous usage of airspace structure by civil and military air traffic which refers to integration of civil military operations in real time;
- Minimising segregation of airspace in real time – military mission profiles need airspace segregation in order to avoid potentially hazardous situations for civil air traffic. Even though Strategic and Pre-tactical phase minimise the impact of segregation of civil air traffic, continuous changes in airspace configuration request the ability to handle great number of transactions between ATC and military units.



**Figure 7: Tactical Airspace Management**

Integration of civil and military activities when they use the same airspace in real time operations is usually the best option as the Flexible Use of Airspace concept strives to avoid any form of segregation. The possibility to integrate military and civil activities depends on: the nature of military activity, level of civil military ATM system integration, the responsibility to provide ATC services which is assigned to the unit (civil or military) which is in best place to ensure it in a given time.

## 5 CONCLUSION

Even though the Flexible Use of Airspace Concept brought benefits to the European ATM environment, future FUA evolution shouldn't end with this Concept. The Concept of Enhanced FUA Operations is aiming at improving current ASM/ATFCM/ATC process and civil/military coordination [12]. The implementation of Enhanced FUA defined by DMEAN Concept of Operations presents the base for the Advanced FUA Concept for 2017. The main feature of the Advanced FUA is the concept of Airspace Configurations, which would represent the extension of the current airspace scenarios that are fixed and static. New Concept would comprise of pre-defined fixed and flexible routing options that would include environmental constraints and optimum ATC sectorisation that would meet the civil/military demand requirements. Strategically planned Airspace Configurations would be capable to dynamically adapt to traffic demand which vary in time and space. The activation of this Airspace Configurations will be on national, sub-regional (FAB) and European Network Level depending on predefined strategic objectives.

Except of extensive use of Airspace Configurations there are other elements that would support the Advanced Flexible Use of Airspace Concept. Following elements represent several major enhancements that Advance FUA would bring. Continuous ASM/ATFCM/ATC operations would enable closer in time identification and coordination of Airspace Configuration in order to overcome capacity shortfalls, while allowing late revised airspace allocation. Use of Dynamic User Preferred Routing Areas (Free Route Concept) where flights would not be constrained by route structure would increase the flight efficiency in ECAC

area. Also the usage of Shared Business/Mission Trajectories would optimise the flight planning process as airspace users would be informed on up-to-date picture of the traffic situation (incl. ASM situation, forecasted data, Historical data, already known intentions, MET forecast, current traffic, and). The implementation of interactive Network Operation Plan presents a 4 dimensional virtual model of the European ATM environment. The NOP presents the rolling picture of the ATM past, present and future environment. Via the appropriate applications it is possible for user able to view NOP moving the window along the timeline and focusing on any particular aspect or aspects he or she is interested in.

Advance Concept of Operations improvements will result in a seamless process converging towards continuous collaborative decision-making based on the information maintained by the SWIM<sup>19</sup>-enabled NOP and updating it at regular intervals.

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<sup>19</sup> SWIM – System Wide Information Management